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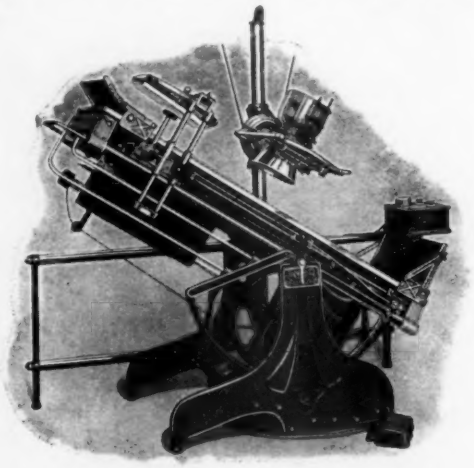

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THE AMERICAN JOURNAL OF ROENTGENOLOGY

Editor, H. M. Imboden, M.D., New York

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THE INTRALARYNGEAL APPLICATION OF RADIRM FOR CHRONIC PAPILLOMATA*

By PRESTON M. HICKEY, M.D., F.A.C.P., F.A.C.S.

DETROIT, MICHIGAN

THE purpose of this paper is to describe the treatment of intractable papillomata of the larynx with radium. The patient on whom this was used is now thirty-eight years of age. Ten years ago she noticed that her voice showed signs of huskiness; soon a complete aphonia developed. She was treated by her family physician and a local laryngologist for a period of two years; at the time I first saw her, she had had a loss of voice for over two years.

Laryngological examination showed that the lumen of the larynx was occluded with papillomatous masses. These partially covered the epiglottis and the false vocal cords. An attempt was made to remove the neoplasm with forceps introduced through the Jackson laryngoscope. On account of the difficulty in hyperextension of the neck, owing probably to shortness of the cervical ligaments, it was found impossible to operate satisfactorily with the direct laryngoscope. Repeated attempts were made, both under local and general anesthesia, to obtain a direct view of the larynx, but these were all unsuccessful. A number of pieces were removed by the indirect method of the laryngoscopic mirror and curved forceps, after which prolonged local treatments were given. The whole category of chemical escharotics usually recommended for this condition was employed. The growths, however, speedily recurred. In fact, incomplete operation seemed to stimulate the neoplasm.

Accordingly, it was decided to do a laryngotomy, as the obstruction was becoming so pronounced. An incision was made and the larynx split, the growths were completely removed by the curette, and the seat of operation was thoroughly cauterized, after which the larynx was closed. Microscopical examination of the pieces removed showed that the growth was a benign papilloma. Recurrence, however, took place in a few weeks, with the return of so much obstruction that an emergency tracheotomy had to be performed. After the tube was inserted and the breathing relieved, the patient received a thorough course of *x*-ray treatments, but no beneficial effect was noted.

During the writer's absence in foreign service, the patient made two trips to a well-known western surgical center, where two unsuccessful attempts were made to introduce the direct laryngoscope. Inasmuch as it was impossible to remove the growth surgically, the patient was treated by applying radium externally. There resulted, however, no diminution in the size of the growths.

On the writer's return, examination of the

*Read at the Twenty-first Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Minneapolis, Minn., Sept. 14–17, 1920.

patient showed that the epiglottis was completely covered on its posterior surface with villous excrescenses, and the interior of the larynx could not be seen, the opening being blocked by the growth. Neither the false nor the true vocal cords could be distinguished. The patient, at this time, had worn the tracheotomy tube continuously for a period of five years. During this time, she had given birth to two children, with no seeming inconvenience from the constant wearing of the tracheotomy tube.

In considering the case from its various aspects, it seemed futile to attempt further surgical treatment, and as the *x*-ray and external application of radium had been unsuccessful, it was decided to attempt the introduction of the radium capsule into the interior of the larynx. The introduction of the capsule with laryngeal forceps presented certain difficulties, as did also the introduction of the radium capsule on a semi-flexible bougie. Accordingly, the tracheotomy tube was removed for a few minutes and a small, flexible bougie was introduced into the trachea, the bougie was passed upward through the larynx and seized by forceps and drawn out through the mouth. A strong thread was then attached and pulled down through the larynx and out through the tracheotomy opening. The radium capsule, with its rubber filter, was then attached to this ligature, and pulled downward by the thread until the capsule was seen by the mirror to be wedged in the superior opening of the larynx. Twenty-five miligrams of radium placed in a rubber filter were allowed to remain in position of one and a half hours. The patient was given a preliminary dose of morphia to quiet the cough resulting from the introduction of foreign material in the larynx. The tracheotomy tube was re-introduced and the lower end of the thread was attached to the tube, while the upper end of the thread was anchored to one of the teeth. In this way, the radium capsule was held immobile during the hour and a half of treatment.

Considerable reaction followed the first séance, but at examination about one month later it was found that the epiglottis was practically clear of papillomata. At the second séance, the radium capsule was drawn well down into the larynx, with the dosage of twenty-five milligrams for one hour. This was followed by only a mild reaction, and partial disappearance of the laryngeal growths. The true and the false vocal cords then became visible.

A third treatment was given after a period of two months, with a similar dosage.

After three treatments, the patient's larynx was practically free of growths, although a few small tags remained, which will be subject to further irradiation. During the past week, a letter was received from the patient in which she states she is now able to dispense with the tracheotomy tube for one-half day at a time.

In presenting this case for discussion, and in giving the case history, we believe that we have, in the intralaryngeal application of radium, a powerful agent for the destruction of chronic, recurrent laryngeal papillomata.

From the laryngological standpoint, papillomata may be divided into two great groups; first, those which are easily amenable to surgical treatment and which do not tend to recur after removal, and, second, those which show a remarkable tendency to recurrence even after the most thorough surgical removal and cauterization. It is in the treatment of this second group of cases, which fortunately are somewhat rare, that the above procedure is recommended.

"Rapid and extensive recurrence in histologically benign form is observed especially in children, and illustrates the remarkable regenerative powers of the laryngeal epithelium. Laryngotomy and excision or cauterization has been performed three, four, and even seven times in a relatively short period before the disease could be arrested (Wilkinson, Lendon, Clubbe). In this group of cases, radium treatment has given excellent results." Ewing, *Neoplastic Diseases.*

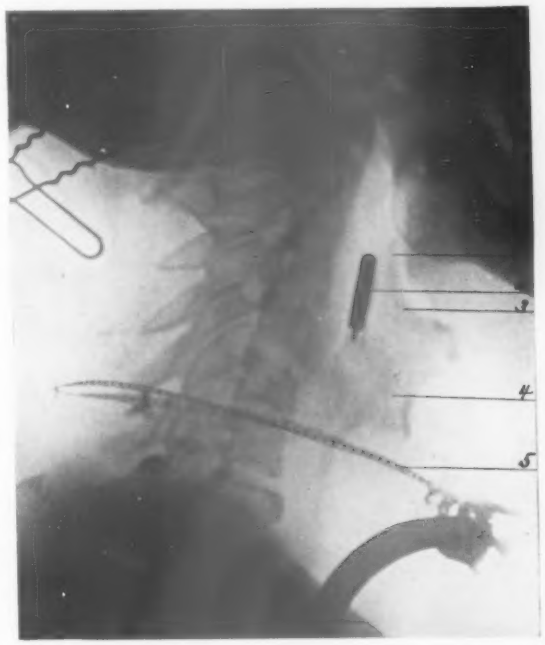
From a purely theoretical standpoint, owing to the slight ability of the radium rays to penetrate tissues, it would seem useless to apply radium externally to the larynx, and

this was found to be true in this particular case. The procedure here recommended, viz., the introduction of a stout thread through the laryngeal and tracheal opening and the immobilization by this means of the radium capsule in the larynx, offers we think a practically sure method of cure of these hitherto intractable cases.

With regard to the technique employed, it is necessary thoroughly to cocainize the laryngopharynx and also the trachea through the tracheotomy opening. At the same time, the patient should be given enough anodyne to keep the cough reflex in abeyance. The observation of the position of the radium capsule in the larynx was difficult when the ordinary laryngeal mirror was employed. Accordingly, it was found more practicable to place the patient before the fluoroscope and, after orientation of the shadow of the epiglottis and of the glottic opening, the position of the radium capsule could be accurately determined. If the capsule was placed too high, it could be readily drawn down by traction on the ligature through the tracheotomy opening. This procedure was found to be much more comfortable for the patient and far more accurate than observation with reflected light. In the introduction of the bougie, it was found much easier to introduce the bougie from below upward, making use of the tracheal opening.

Since the employment of the intralaryngeal applications in this case, the writer has had the opportunity of using the radium capsule in an advanced case of carcinoma of the larynx, where a tracheotomy had been performed for the relief of obstruction to breathing. In this case, it was difficult to introduce the bougie through the tracheotomy opening up into the larynx. Acordingly, the tracheotomy tube was reinserted with the tracheal end pointing upward, this permitting the bougie to pass upward into the larynx. This procedure had to be performed expeditiously, inasmuch as the patient's respirations were, of necessity, cut off.

While the observations on the effect of the treatment of carcinoma by the radium capsule are as yet incomplete, the fact remains that it is perfectly feasible to retain in this way any desired quantity of radium in intimate contact with the diseased tissue for any length of time desired.



1. Epiglottis.
2. Radium Capsule.
3. Hyoid Bone.
4. Thyroid Cartilage.
5. Chain for Retaining Tracheotomy Tube.

Where it is not desirable to perform a preliminary tracheotomy, it is possible to use an intubation tube having a groove cut in its side for the holding of the radium capsule. The method described above, of intralaryngeal application is only put forward as a suggestion for treatment in cases where all other methods have failed.

OBSERVATIONS ON THE BEHAVIOR OF THE NORMAL PYLORIC SPHINCTER IN MAN*

By C. W. McCLURE, M.D., and L. REYNOLDS, M.D.

BOSTON, MASSACHUSETTS

EXPERIMENTAL studies on the physiological factors influencing the motor functions of the gastro-intestinal tract and the relation of these motor phenomena to the digestion and absorption of food products have been largely carried out on animals. But the results obtained from such studies can be applied only in a general way to the physiology of the digestive tract in man. It follows that more intimate knowledge concerning various phases of the physiology of the alimentary canal in man would aid in the interpretation of results obtained from experimental studies of the pathological physiology of human digestion. For this reason certain phases of the motor functions of the normal stomach in man were studied. The present preliminary report largely deals with work bearing on the question of "acid control" of the pyloric sphincter in man.

Cannon elaborated the theory, suggested by Pawlow among others, that acid controlled the action of the pyloric sphincter in animals. In epitome this theory is that the presence of acid in the antrum of the stomach causes relaxation of the pyloric sphincter, while the presence of acid in the duodenum causes the sphincter to contract. The evidence on which this theory is based was obtained from experiments carried out on animals. Phenomena occur in animals which the theory of "acid control" does not explain, and for this reason other controlling factors are assumed to exist. Whether or not acid or some other factor exerts the principal control over the pyloric sphincter in man has not been demonstrated, and with the problem the present investigation is concerned. The results obtained by previous investigators will be discussed later.

The object of the present study has been to determine:

1. The degree of contraction of the pyloric sphincter when foodstuffs partially fill the normal stomach.

2. The behavior of the sphincter relative to the passage of carbohydrate, protein, or fatty foods from the normal stomach into the duodenum.

3. The effect on the pyloric sphincter of direct application of hydrochloric acid and sodium bicarbonate solutions to both its antral and duodenal ends.

These observations of the stomachs of normal persons were made by means of the fluoroscope after feeding meals composed of thick porridge and barium or 140 gm. of ground lean meat and 4 gm. of barium sulphate baked into a loaf, or 120 gm. of ground fatty bacon, 5 egg yolks and 40 gm. of barium sulphate baked into a loaf. The protein and fatty meals were of constant bulk and consistency.

1. *The degree of contraction of the normal pyloric sphincter.*— That the pyloric sphincter is closed when fluid food is in the stomach, except during the periods in which it opens to permit the ejection of food into the duodenum, was demonstrated in 1913 by Cole. His observations were so readily and easily confirmed by fluoroscopic studies that they are now universally accepted. The authors have confirmed Cole's observations by means of the fluoroscope a large number of times. Further evidence that the normal quiescent sphincter is in a state of contraction is afforded by the fact that barium mixtures can be forced from the stomach into the duodenum only by the use of consider-

*Read at the Twenty-first Annual Meeting of The American Roentgen Ray Society, Minneapolis, Minn., Sept. 14–17, 1920.

able pressure on the abdominal wall and only when the sphincter has opened in relation to the advance of an antral peristaltic wave. When this is successful the filled antrum and first portion of the duodenum are seen to be connected by a narrow isthmus of barium, which represents the lumen of the sphincter; on cessation of pressure this narrow isthmus disappears.

2. *The behavior of the pyloric sphincter relative to the passage of carbohydrates, protein and fatty foods from the stomach into the duodenum.*—In the routine clinical *x*-ray examination of the stomach a carbohydrate meal consists of 500 c.c. of malted milk solution in which 90 gm. of barium sulphate are held in suspension by the aid of potato starch. The meal starts through the normal pyloric sphincter immediately or within a few minutes after it has been ingested. The normal sphincter opens regularly, as each antral peristaltic wave approaches, and permits the passage of the barium meal into the duodenum over a period of about ten seconds. In two young men with normal stomachs the same phenomenon occurred after the ingestion of thick oatmeal porridge mixed with barium. Except in abnormal conditions accompanied by pylorospasm, opening of the pyloric sphincter at irregular intervals, as described by Cannon in cats, was not observed. The regular opening and closing of the pyloric sphincter, except in the presence of pylorospasm, is so well known that no further work on carbohydrate meals was deemed necessary in the present investigation.

Observations on the behavior of the pyloric sphincter after the ingestion of protein food were made on eleven young men, ten with normal stomachs, one with a quiescent duodenal ulcer, and one woman whose stomach was normal.

Similar observations were made after the ingestion of fatty food in six normal young men. The duration of each experiment varied from thirty minutes to six hours. In these experiments the food was seen to pass from the stomach into the duodenum in normal amounts as each peristaltic wave approached the pyloric orifice. By normal amounts is meant that quantity of barium which passes through the pyloric sphincter after the ingestion of the barium meal commonly used in an *x*-ray examination for diagnostic purposes. The amounts of foodstuffs and of water fed in these experiments formed a very thick mush when thoroughly mixed together in a mortar. To obviate the criticism that the consistency of the food permits it to act more like liquid than solid foods, the meat and fatty meals were administered without the addition of water. The result obtained was the same, namely, the foodstuffs began to pass through the pylorus immediately.

Our observations seem to indicate that both fatty and protein meals begin to leave the stomach within three to ten minutes after the food has been swallowed. Furthermore, the food passes through the sphincter into the duodenum as each peristaltic wave approaches the pylorus. The amounts of a single food or of different ones which pass through the sphincter during a given time do not vary in the same individual.

3. *The effect of hydrochloric acid and sodium bicarbonate solutions on the pyloric sphincter.*—Solutions of hydrochloric acid and in a few instances of sodium bicarbonate were introduced into the duodenum and the effect on the opening and closure of the pyloric sphincter was ascertained. The behavior of the sphincter was constantly observed through the fluoroscope. The activity of the sphincter was determined by the passage or non-passage of barium from the stomach into the duodenum.

The subjects used were hospital patients whose physical condition at the time of the experiments was considered to be normal. The usual gastric analyses of these patients showed no abnormalities.

The observations on the effect of hydrochloric acid and sodium bicarbonate solutions on the pylorus were made as follows: the duodenal tube was passed subsequent to a twelve hour fast; the tube was allowed to

pass into the duodenum. The time required for the tube to pass from the stomach into the duodenum was variable; at times it was only a question of minutes and at others it required an hour or more. After the tube had entered the duodenum a meal was fed.

The meal consisted of a meat and barium meal either rinsed down with 200 c.c. of water or made in a mush by grinding in a mortar with 100 c.c. of water. In certain cases, where the subject was unable to eat the whole meal prepared, we gave an additional malted milk, potato starch and barium mixture to enable us more completely to visualize the sphincter; however, this was necessary in only two cases.

After the patient was observed a sufficient length of time to determine that the peristaltic waves were orderly and regular we began the instillation of solutions of hydrochloric acid and sodium bicarbonate. In some instances an N/40, in others N/20 and in one case an N/10 hydrochloric acid warmed to body temperature was instilled in from 5 c.c. to 20 c.c. amounts into the first, second and third portions of the duodenum. The time of the instillation was varied in relation to the normal opening time of the pyloric sphincter. In some cases an injection was made just prior to the normal opening time of the pyloric sphincter and this was gauged by the observation under the fluoroscope of the advance of an antral peristaltic wave. In other instances the instillation of 20 c.c. of the acid was begun as an antral peristaltic wave reached the sphincter and the instillation continued until the sphincter had opened and closed several times. In another series of experiments a 1 per cent solution of sodium bicarbonate was used in place of the acid and the pylorus was similarly observed. In these experiments on four individuals no effect was observed on the opening time of the sphincter, the amounts of barium passing through it, or upon its time of closure. It will be seen consequently that the behavior of the sphincter is the same whether acid or alkali is introduced into the duodenum. In a fifth subject the introduction of N/20 hydrochloric acid or of 1 per cent sodium bicarbonate into the first portion of the duodenum produced either complete or partial pylorospasm and vigorous duodenal antiperistalsis. This rather unexpected behavior was subsequently explained by the discovery of a duodenal ulcer. In a subject the introduction of N/20 hydrochloric acid into the third portion of the duodenum produced either complete or partial pylorospasm associated with the development of very shallow gastric peristaltic waves. In one subject a loop of the duodenal tube passed through the sphincter into the duodenum leaving the metal tip in the antral end of the pyloric sphincter. This permitted solutions to escape from the orifice of the tube directly onto the antral portion of the sphincter.

DISCUSSION

Our observations demonstrate that finely divided foods, regardless of whether they are solid or liquid, begin to leave the stomach within a very short period of time. Thus barium was observed to pass the sphincter in the time required for the subject to ingest the meal and be prepared for fluoroscopic observation, which was always less than ten minutes. It was of interest to observe that carbohydrates, fats and proteins behaved alike in this respect—contrary to what one would expect from reports of animal observations. That this phenomenon is true for carbohydrate meals has already been stated. But with the exception of Cole no observations in man of other types of meals have been published, and his publication unfortunately gives no experimental details. The barium meal passed through the pyloric sphincter as each antral peristaltic wave approached that orifice. Cole has previously made similar observations. The opening of the pylorus at irregular intervals, as described by Cannon in cats, was not noted. It was observed that the antral portion of the stomach was quiescent except for peristaltic waves which at regular intervals swept over it. The contents of the antrum were consequently not undergoing a mixing process and

the same food must have remained in contact with the gastric mucosa. Therefore, the surface of the antral mucous membrane would be covered with material of a fairly constant degree of acidity. It is very probable that the reaction of this material is acid. This statement is based upon the following facts:

1. The authors have found in two subjects, after feeding a meat meal, the food when first ejected from the stomach into the duodenum to contain free hydrochloric acid in the strength of N/60 and N/500. The position of the metal tip of the duodenal tube and the phenomena transpiring in the stomach and duodenum at the time the specimen for analysis was withdrawn were determined by fluoroscopic observation.

From the above it follows that in order for the stimulation of acid in the stomach to open, and in the duodenum to close the sphincter, there must be assumed the existence of a very delicate balance between the antral and duodenal reflexes in relation to the presence of the same degree of acidity, the duodenal reflex being much the more sensitive.

McClendon and Meyers and the authors have found the contents of the first portion of the human duodenum to be either neutral or of low acidity. After emptying itself of food just ejected from the stomach the duodenum will, therefore, be practically neutral in reaction, and in the presence of pancreatic juice possibly alkaline. Then if acid in the stomach causes the sphincter to relax, the sphincter should become patent when the duodenum empties itself of food. That this is not the case is demonstrated by the difficulty experienced in pushing barium through the sphincter into the duodenum by palpation of the abdominal wall. In fact, it is probable that barium can be caused to enter the duodenum by this means only when the sphincter opens in relation to the advance of an antral peristaltic wave. From this it follows that, if the pyloric sphincter is under "acid control," then the fact that it opens at regular intervals and normally only in a definite relation to the advance of an antral peristaltic wave makes it necessary to assume either (1) that there is a finely adjusted acid regulatory mechanism in the antral region of the sphincter which produces the proper degree of acidity to relax the sphincter at a fairly exact time in relation to the approach of a peristaltic wave toward the sphincter; or (2) that a comparable mechanism for properly neutralizing the contents of the duodenum must exist. If either or both such mechanisms exist they must be so adjusted as to permit of changes in the rhythm of the time of opening of the sphincter, as occurred in one of our experiments after pouring alkali onto the end of the pyloric sphincter. Furthermore, while the sphincter closes suddenly it remains open an appreciable length of time. Barium flows through the sphincter as an antral peristaltic wave approaches and continues to do so until the wave has spent itself. The sphincter, therefore, does not close as soon as acid enters the duodenum, and the presence of acid we have demonstrated experimentally. If acid in the duodenum causes closure of the sphincter then either (1) the proper degree of acidity must be always developed at a time when an antral wave has spent itself, or (2) a secondary mechanism in some way regulating the reflex must be assumed.

The existence of the various factors outlined are necessary to explain the theory of "acid control" of the sphincter, and their existence has not been proved. The assumption of the existence of these factors renders the mechanism of the control of the sphincter exceedingly complex. It is possible that some other less complicated mechanism may exist in man. The latter has been suggested, but not proved, by Luckhart, Phillips and Carlson. These investigators found that a relation exists between the muscular activity of the antrum and the opening of the sphincter.

In four of the experiments here reported it has been shown that acid introduced into the duodenum did not prevent the opening of the sphincter. These observations do not support the theory that acid in the duodenum causes contraction of the pyloric sphincter. Furthermore, sodium bicarbonate was poured into the duodenum in a quantity

which, judging from the limited observations of the degrees of acidity of the duodenal contents, was sufficient to bring about neutralization. The latter must have occurred in an experiment in which 5 per cent sodium bicarbonate solution was allowed to flow into the duodenum. The carbonate solution was introduced on two occasions in quantities of 10 c.c. and 20 c.c. after the pyloric sphincter had opened and up to the time of its complete closure. Before the introduction of the carbonate solution the chyme was collected as it was poured into the first portion of the duodenum during the latter half of the time the sphincter remained open. This allowed the first portion of the chyme to clear the region of the metal tip of duodenal contents. The concentration of free hydrochloric acid in the chyme was N/500, and of total acidity N/25 (titrated to phenolphthalein). According to the "acid control" theory, the sphincter should have remained patent as long as the duodenal contents in these experiments were alkaline. This it did not do, but was observed to close completely. However, absolute evidence that the amount of carbonate introduced neutralized all the acid in the duodenum could not be obtained, although but little doubt can exist that neutralization was effected.

CONCLUSIONS

Conclusions drawn from the experimental work here presented are as follows:

1. Finely divided carbohydrate, protein or fatty foodstuffs begin to leave the normal human stomach within from three to ten minutes after their initial ingestion.

2. Under normal conditions the human pyloric sphincter opens regularly at the approach of each antral peristaltic wave, allows chyme to pass through into the duodenum during an appreciable length of time, and closes when the antral peristaltic wave has spent itself.

3. The introduction of N/40, N/20 or N/10 hydrochloric acid solutions into the first, second or third portions of the normal human duodenum either produced no effect on the opening of the pyloric sphincter as observed by means of the fluoroscope, or produced effects which were interpreted as the result of abnormal irritation of the duodenal mucosa.

4. Neutralization of the contents of the first portion of the duodenum did not prevent the closing of the pyloric sphincter.

5. The experimental results obtained offer evidence that acid is not the principal factor controlling opening and closing of the pyloric sphincter in man.

LEATHER-BOTTLE STOMACH (LINITIS PLASTICA)*

Report of Five Cases with Remarks on Relationship to Syphilis and Cancer of the Stomach

By LEON T. LEWALD, M.D.

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Director Roentgen Ray Department St. Luke's Hospital, New York;
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NEW YORK CITY

IN view of the number of recently reported cases of syphilis of the stomach, which simulates in appearance that of the leather-bottle stomach, it seems advisable to revise our ideas of the roentgen diagnosis of this condition.

Despite the difficulty of attempting to differentiate by roentgen methods alone diffuse infiltrating scirrhus carcinoma from syphilitic infiltration, or fibrous infiltration of the stomach, it is, nevertheless, possible to distinguish these cases one from the other in a large enough proportion of cases at least to facilitate and augment clinical diagnosis; and in many instances it is possible to make an absolutely correct diagnosis when taken in conjunction with the Wassermann test.

The leading monographs on leather-bottle stomach have been and are based largely upon clinical, operative or postmortem evidence; but with the addition of roentgen methods of study of living pathology, which permit of diagnosis in life, heretofore not possible, our knowledge of the subject is considerably supplemented.

The term "leather-bottle" appears to be based upon the consistency and thickness of the stomach wall rather than from any definite resemblance to our modern bottles; though the narrowing of the pyloric end of the stomach and a compensatory widening of the cardiac end would seem to be the reason for calling it a "leather-bottle" stomach, after the leathern water bottles of the early Egyptians. Schrumpf (1876) calls it "field-canteen" stomach.

Dr. H. H. M. Lyle[1] in 1911 collected seventy cases, described under the term linitis plastica or cirrhosis of the stomach, and reported a case cured by gastrojejunostomy. This case has been under observation for nine years and is still alive, Dr. Lyle informs me.

Carman[2] (1920) has reported three cases.

From our roentgenologic observation of these cases, it appears that the peculiar type of stomach to which the term "leather-bottle" has been applied may represent any one of three conditions: first, fibromatosis; second, syphilis; third, diffuse carcinoma.

Cases illustrating these three types together with the roentgen findings are reported below:

Case Histories

Case I. Leather-Bottle Stomach Due to Fibromatosis.—H. O., female, aged fifty. Seven months prior to admission to St. Luke's Hospital the patient noticed a tumor in the epigastrium, which on examination was found to be firm, movable and nontender. There was no complaint of pain, vomiting, nausea, sour eructations or jaundice. Solid foods caused gastric distress followed by some belching of gas; there were several bloody stools but no tarry ones; a loss of forty-five pounds in one year. The general appearance was that of a fairly well nourished, not acutely ill woman.

Gastric analysis, free HCl—0, total acidity —30.

Roentgen examination revealed a deform-

[1] *Annals of Surgery*, Nov. 1911.

[2] Carman and Miller. Roentgen Diagnosis, Diseases of the Alimentary Canal. Saunders, 1920.

*Read at the Twenty-first Annual Meeting of The American Roentgen Ray Society, Minneapolis, Minn., Sept. 14-17, 1920.

ity of the horizontal portion of the stomach involving about one third of the stomach wall. (Fig. 1). It was very smooth and resembled closely a specific infiltration. Both the greater and lesser curvatures were involved. The stomach emptied at an exceedingly rapid rate, the meal meeting with practically no delay at the pylorus, so that in five minutes the small intestine was filled. The duodenum was slightly dilated. At the cardiac end of the stomach there was some irregularity about the entrance to the esophagus, suggesting infiltration of this region. The stomach practically emptied itself in one hour. At the sixth hour the meal had reached the hepatic flexure. A considerable portion of the meal had been eliminated at the twenty-fourth hour.

A confirmatory examination showed the deformity of the stomach persisting and fluoroscopic examination showed the mass in the abdomen to be related to the deformity of the stomach wall.

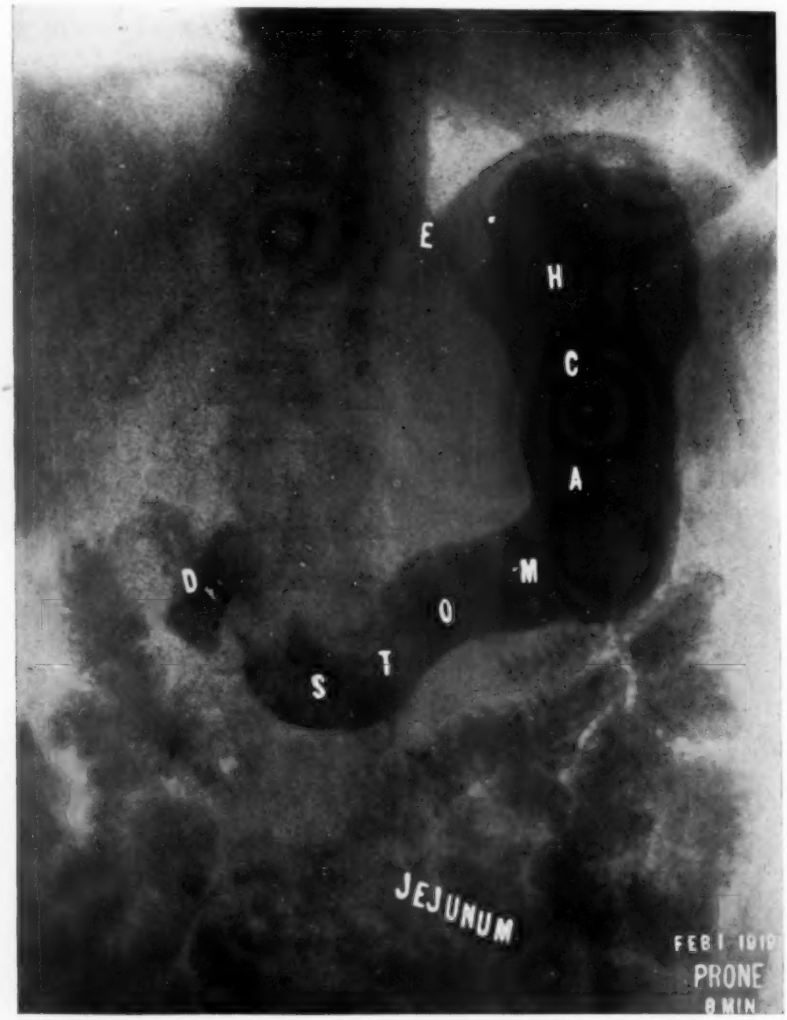

FIG. 1. CASE I. LEATHER-BOTTLE STOMACH DUE TO FIBROMATOSIS. Eight minutes after meal. Deformity of stomach involving greater and lesser curvatures. Irregularity at esophageal entrance indicating infiltration. Microscopic examination showed increase in fibrous tissue but *no evidence of cancer.*

Preoperative clinical diagnosis: Carcinoma of the stomach. At operation the stomach was found infiltrated with a large tumor

mass extending over the lesser curvature from the cardia to the pylorus. Lymphatics dilated, but no enlarged or palpable glands; no epigastric adhesions. Incision made in the stomach just above the pylorus and two small pieces removed for microscopic examination.

Pathologic examination of the specimen taken from stomach wall showed considerable thickening, apparently in the submucosa. The mucosa appeared normal and the serous coat was smooth and shining. The smaller fragment consisted only of mucosa and submucosa. The latter was greatly thickened. There was no evidence of any gross lesion.

Microscopic examination of the specimen showed that there was a very considerable increase in the fibrous tissue of the submucosa. This was very thick, rather dense, contained large fibroblastic nuclei which were well stained and gave the form of cellular tissue. The mucosa was normal overlying this, or in some places was slightly hypertrophic. Blood vessels were only moderately thick-walled, showing comparatively little change. There was no perivascular infiltration, and only very little infiltration of the fibrous tissue, except along the deep surface of the mucosa where there were rather numerous lymphocytes. The pathologic lesion appeared only as a diffuse overgrowth of fibrous tissue.

No cells suggestive of a neoplasm could be detected in the section.

Patient was placed on anti-syphilitic treatment in spite of the negative Wassermann examination. No improvement resulted.

Roentgen examination five weeks after operation and about three weeks after the beginning of treatment showed practically no change in contour or emptying time of the stomach. (Fig. 2.)

Eleven months later the patient returned to the hospital complaining of abdominal distention of two months' duration, combined with a swelling of the legs for two weeks. She was able to take only a small amount of food at a time. There was no dyspnea or cardiac distress; no jaundice, pain or constipation. The lump in the epigastrium was still present. She gained in weight after the operation but then became so weak she was quite unable to walk.

Physical examination: patient fairly well nourished and developed; not acutely ill; no cyanosis, jaundice or dispnea. Abdomen was distended, tense, dull in flanks; fluid was present in epigastrium; irregular, large mass just above umbilicus; no rigidity. Gastric analysis: free HCl—0; total acidity—10.

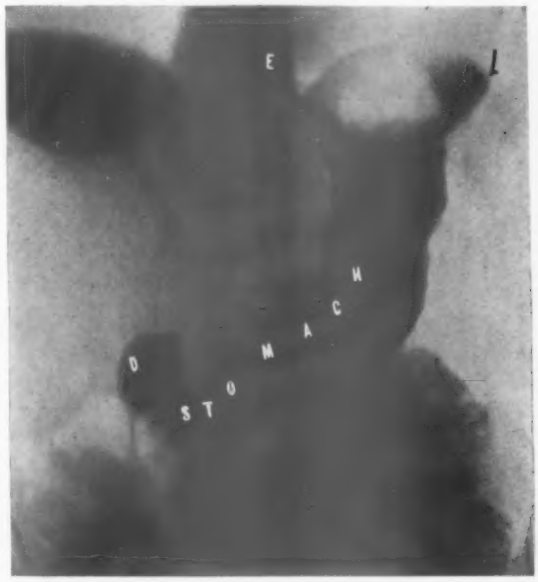

FIG. 2. CASE I. (Same case as Figure 1.) FIBROMATOSIS. Five weeks after exploratory operation and removal of section. Ten minutes after meal. Practically no change in contour or emptying time of stomach.

Fluoroscopic examination showed distinct delay in the esophagus, indicating spasm or organic constriction at the cardiac end of the stomach.

Roentgen examination: the stomach remained very small as noted at previous examination. The greatest transverse diameter of the stomach was only 5 cm. This confirmed the diagnosis of leather-bottle stomach. Greater curvature 3 inches above the umbilicus. At the fourth hour, the stomach was entirely empty. No delay in the ileum.

The colon was sluggish. Most of the meal remained in the transverse portion of the colon at the twenty-fourth hour.

At the forty-eighth hour some of the meal

had reached the sigmoid. Traces remained in the transverse portion of the colon.

The abdomen was aspirated and 10 c.c. of fluid removed. No operation. No medication, except tonic. Rest.

vice of St. Luke's Hospital, New York, by Dr. Samuel Lambert on September 29, 1914, with a provisional diagnosis of gastric ulcer.

History: Patient had suffered from pain and vomiting for two years with a loss of

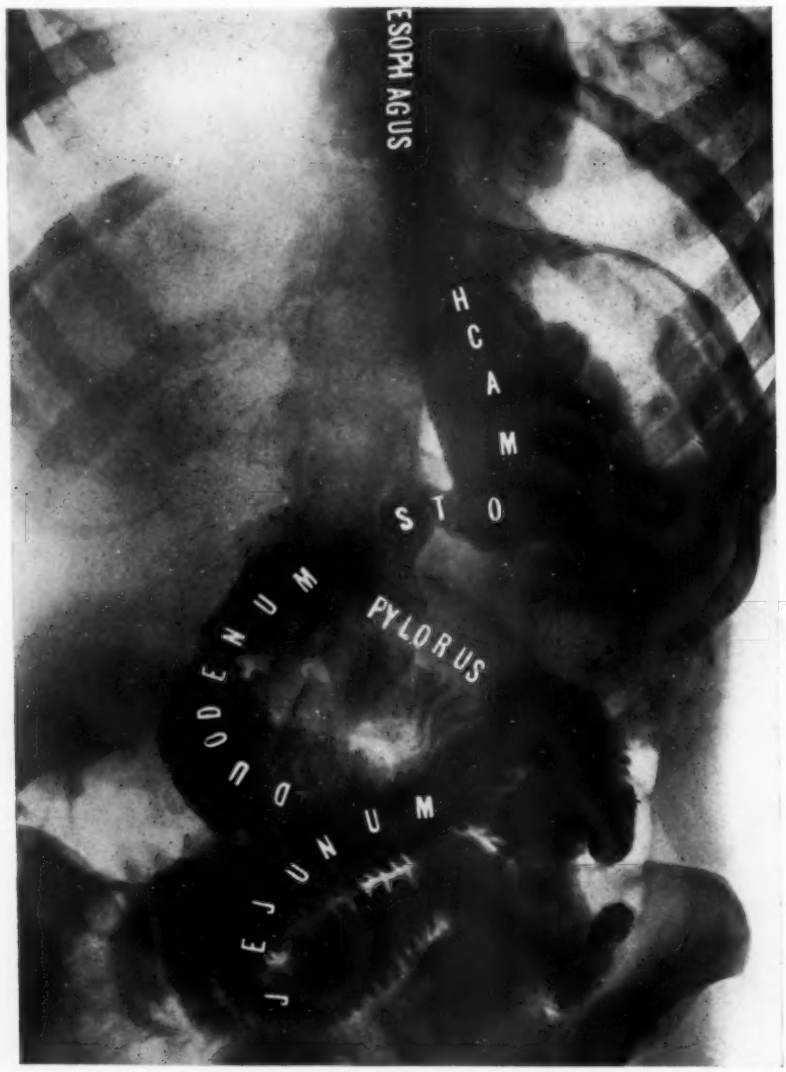

FIG. 3. CASE II. LEATHER-BOTTLE STOMACH DUE TO SYPHILIS. (AGED TWENTY-THREE.) Two minutes after meal. Note diminished size of stomach with compensatory dilatation of esophagus and rapid passage of the meal through the pylorus.

CASE II. LEATHER-BOTTLE STOMACH DUE TO SYPHILIS.[3]—M. A., female, aged twenty-three, married. Case referred for roentgen examination from the medical ser-

fifty pounds in weight. Four months previously she had had a therapeutic abortion performed *for persistent vomiting* and a similar occurrence once before that, three months after her marriage. Whenever she took food she was seized with a sharp pain in the epigastrium followed by vomiting in

[3] This case is one of a group of cases of syphilis of the stomach reported in AMERICAN JOURNAL OF ROENTGENOLOGY, February 1917, iv, 76, by the author.

about fifteen minutes, which relieved the pain. Test meal: blood, 0; lactic acid, 0; free HCl, 0; total acidity, 14.

Roentgen examination showed a peculiar deformity involving the pyloric half of the stomach. (Fig. 3.) This region appeared to be infiltrated, together with the pyloric ring which is held open allowing the food to pass out of the stomach in a most remarkable manner. At the sixth hour there was a small residue high up in the cardiac end of the stomach. Syphilis of the stomach was diagnosed and a Wassermann examination advised. It was reported four plus.

On October 5, 1914, a confirmatory examination was made. This duplicated the finding of a peculiar deformity involving the pyloric half of the stomach causing a considerable narrowing of the lumen, an appearance which is characteristic of syphilis of the stomach. (Fig. 4.) On November 11, 1914, another examination was made after the patient had been placed on anti-spyhilitic treatment following the findings of a positive Wassermann reaction. Nausea and vomiting had ceased and weight had been gained. Roentgen examination showed the peculiar deformity of the stomach persisting and at the sixth hour there was a small residue at the cardiac end of the stomach.

March 1, 1915, patient remarkably improved, had gained forty-four pounds in weight, and was entirely free from pain and vomiting. Roentgen examination showed the deformity at the pyloric end of the stomach still persisting and the stomach emptying at a very rapid rate. (Fig. 5.) At the sixth hour there was a very small residue in the cardiac end of the stomach, very much as in the earlier examination.

February 16, 1916, roentgen examination showed still further improvement in the size of the stomach, indicating some absorption of the infiltration. This was particularly evident about the pylorus, the sphincter having regained its function so that food passed through it at about a normal rate instead of at the excessive rate previously noted. She was free from all stomach symptoms

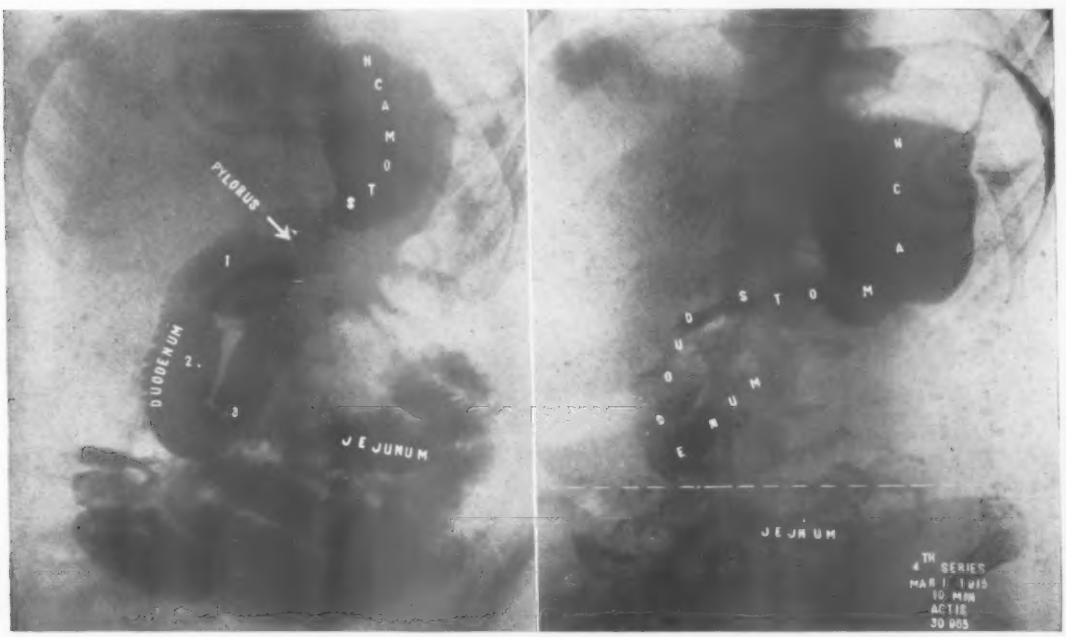

Fig. 4. Case II. (Same case as Figures 3 and 5.) Syphilis. (Aged Twenty-three.) Confirmatory examination. Five minutes after meal.

Fig. 5. Case II. (Same case as Figures 3 and 4.) Syphilis. (Aged Twenty-three.) Five months after medical treatment. Ten minutes after meal. Cessation of symptoms. Increase in size of stomach with less rapid emptying.

and had gained fifty-four pounds in weight.

November 20, 1916, gave birth to a healthy child.

CASE III. LEATHER-BOTTLE STOMACH DUE TO CARCINOMA IN A GIRL TWENTY-THREE YEARS OF AGE.[4]—D. V., admitted to St. Luke's Hospital March 24, 1919, with a clinical diagnosis of anemia. Possible cause, carcinoma of the stomach or splenomegaly.

History: four months ago patient began to suffer from indigestion, especially noticeable about one-half hour after meals and lasting from one to one and a half hours. At first there was no nausea or vomiting, but later it was accompanied by incessant vomiting. There was no blood in the vomitus. There was marked loss in weight.

Physical examination; a very poorly nourished adult female, decidedly pale, with drawn features. Abdomen: there was a mass in the epigastrium extending to the left side and palpable two inches below the costal margin. It moved with respiration and had a very distinct edge. It appeared to represent either the left lobe of the liver or the spleen. Wassermann reaction negative. Gastric analysis: free HCl—0; total acidity—0.

Roentgen examination: the fluoroscope revealed a most remarkable condition. The opaque meal passed immediately out of the stomach. The condition resembled very

FIG. 6. CASE III. LEATHER-BOTTLE STOMACH DUE TO CARCINOMA, IN A GIRL TWENTY-THREE YEARS OF AGE. Two minutes after meal. Note dilatation of the esophagus, diminished size of stomach with rapid emptying. Microscopic examination: carcinoma.

[4] This is the earliest age in which carcinoma of the stomach has been observed by the author. A case at the age of fifteen years is abstracted in the *Journal of the American Medical Association*, April 2, 1921.

closely that observed in several cases of syphilis of the stomach. The opaque meal examination confirmed the fluoroscopic findings of a remarkably small stomach with a gaping pylorus. So rapid was the emptying of the stomach that a roentgenogram was made with extreme difficulty, taken while the patient was in the act of swallowing and prone on the table. (Figs. 6, 7, 8.) The stomach as thus outlined measured only about 11 by 3 cm. Eight days later a confirmatory examination was made with the patient in the prone position. A partial filling of the esophagus could be made out, suggesting some attempt at compensatory dilatation to make up for the small-sized stomach.

The patient was operated upon April 23, 1919. The duodenum, pylorus and distal inch of the stomach were apparently normal. Proximal to this was a lump which was sharply marked by a hard indurated line. The stomach was contracted and the walls were the seat of nodular induration which felt carcinomatous to the operator. Surrounding the stomach there were a few hard nodes. The stomach was closely adherent to the under surface of the liver. A jejunostomy was performed and a tube inserted.

Pathological examination. Specimen removed at operation consisted of a small node from the greater curvature with considerable inflammatory tissue surrounding it. It was very firm and white on section.

Microscopic examination of the section showed a considerable amount of inflammatory tissue invading the fat. There was also a small lymph node which was almost entirely fibrous. This fibrous tissue and fat were diffusely invaded by small epithelial cells growing singly or in slender tubules apparently in the lymph vessels. They were only moderately hyperchromatic, the nuclei were rather large in proportion to the size of the cell, although the entire structure was comparatively small. Some of the blood vessels were very thick-walled and the coats were extensively invaded by these small cells. The fat appeared to be actively growing since there were numerous nucleated cells with a pale cytoplasm as well as fat vacuoles without nuclei. Diagnosis: Carcinoma in inflammatory tissue from greater curvature of stomach.

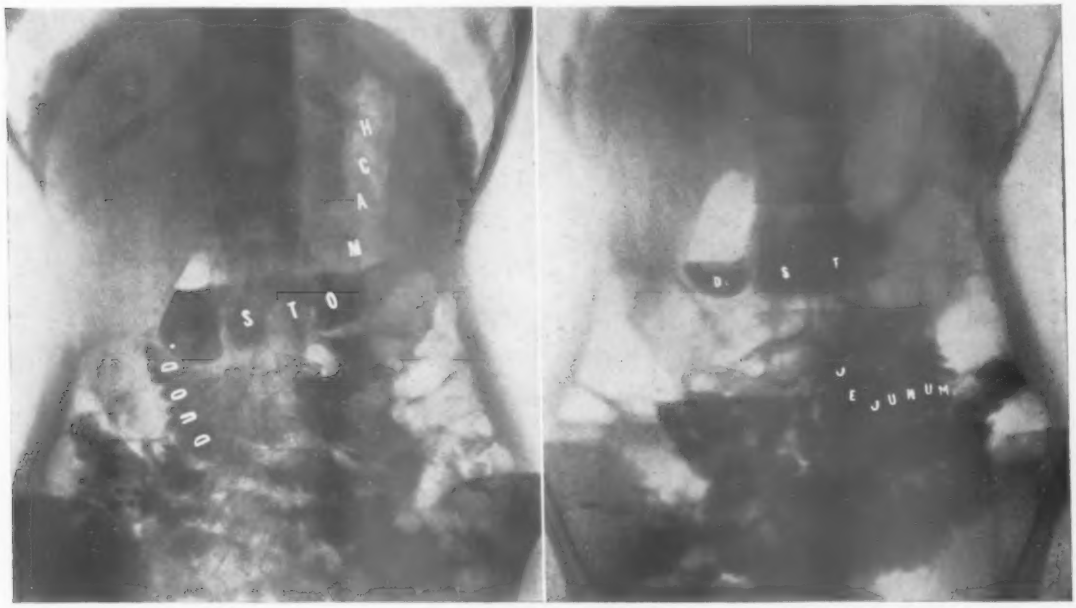

FIG. 7. CASE III. (Same case as Figures 6 and 8.) CARCINOMA. (AGED TWENTY-THREE.) Six minutes after meal. Meal passing rapidly into jejunum.

FIG. 8. CASE III. (Same case as Figures 6 and 7.) CARCINOMA. (AGED TWENTY-THREE.) Eight minutes after meal. Stomach almost entirely empty.

In spite of the operative procedure the patient continued to lose weight and strength and died two weeks later. Autopsy revealed cancer of the stomach and the following notes were extracted from the autopsy record: The neoplasm began at the cardia. The cancer extended along the lesser curvature and stopped short about 3 cm. above the pyloric opening. The lesser curvature was greatly thickened. The omentum was firmly fixed to the greater curvature and a little of the fundus remained free from the growth. The pancreas was adherent to the stomach and on section appeared to be normal. The stomach was contracted, measuring but 10 cm. in its vertical axis. (Fig. 9.) The liver showed no evidence of metastatic involvement.

FIG. 9. CASE III. CARCINOMA OF THE STOMACH. (AGED TWENTY-THREE.) Photograph of stomach showing diminished size and thick wall.

[A fourth case of a very similar-shaped stomach has been encountered and explored surgically and the microscopic examination showed the presence of carcinoma of the peritoneum, but the exact site of the original tumor could not be determined. It probably originated in the stomach. The history is as follows:]

CASE IV. LEATHER-BOTTLE STOMACH PROBABLY DUE TO CARCINOMA.—C. M., male, aged fifty-six. Has complained of stomach trouble for nine months; suffered from vomiting and pain in the abdomen. Admitted to St. Luke's Hospital, July 12, 1919, under the service of Dr. Nathan Green.

Roentgen examination revealed a remarkably small stomach, measuring about 12 by 4 cm. in diameter. (Fig. 10.) The pylorus was gaping so that the duodenum and upper jejunum were filled within a few minutes. There was secondary dilatation of the esophagus. The findings were typical of leather-bottle stomach and closely resembled cases of syphilitic infiltration of the stomach wall. Wassermann was negative.

Exploratory laporotomy was performed

July 22, 1919, by Dr. Green. The abdomen was markedly distended. There was free fluid in the peritoneal cavity. The intestines were matted together owing to numerous adhesions and covered by minute carcinomatous growths. The stomach and transverse colon were matted together so that it was impossible to determine the primary seat of the carcinoma. Both the stomach and the transverse colon were infiltrated with the new growth. The liver was hard and nodular and studded with metastatic nodules. A section was removed for microscopic examination from the infiltrated omentum.

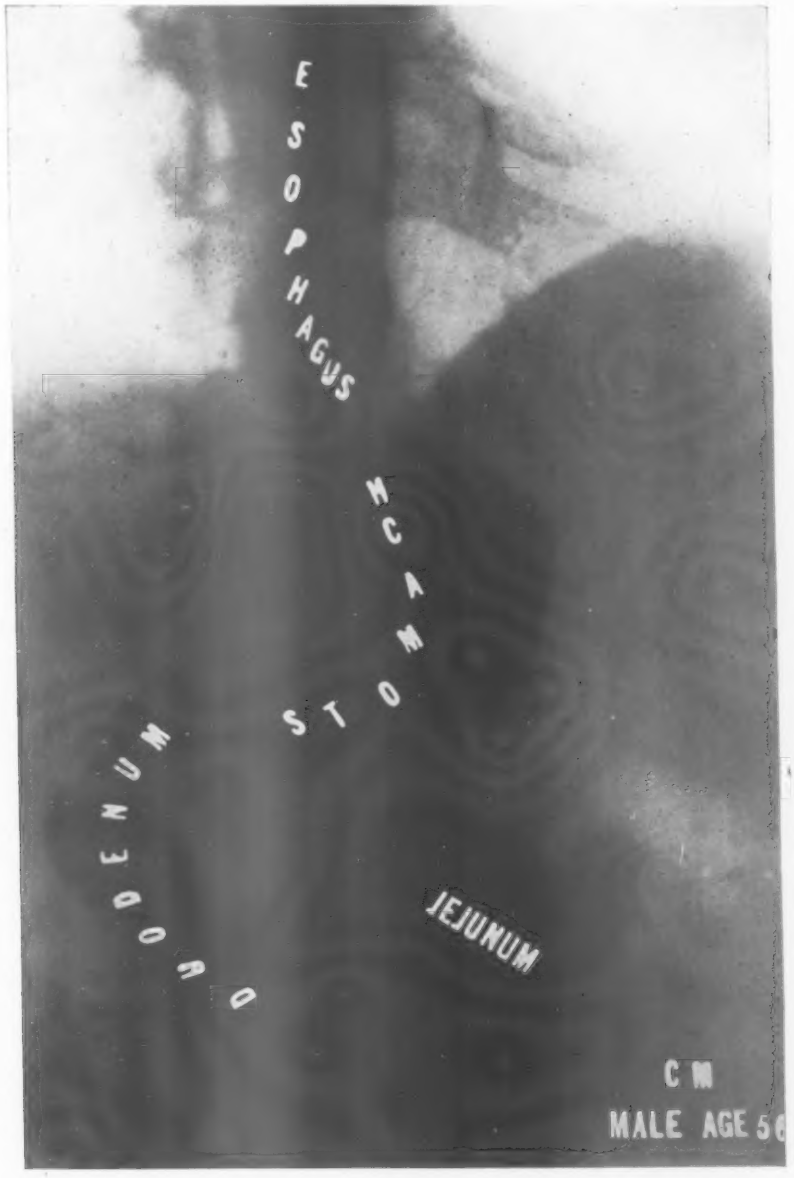

FIG. 10. CASE IV. LEATHER-BOTTLE STOMACH DUE PROBABLY TO CARCINOMA. Fifty minutes after meal. Note small size of stomach with compensatory dilatation of esophagus. Pathologic examination: metastatic carcinoma from abdomen; origin of growth not evident.

Microscopical examination reported by Dr. L. C. Knox. Section consisted of fatty

tissue with extensive productive inflammation and large collections of lymphocytes, and throughout this a few infiltrating carcinomata cells. The cells were rather small and were found in small groups only, but the nuclei were large, hyperchromatic, and showed numerous mitoses. There was no tendency to form glands and no evidence as to the possible origin of the growth. Diagnosis: Metastatic carcinoma from abdomen.

Discharged from the hospital August 7, 1919.

[Note: Just prior to publication of this article an additional case of leather-bottle stomach has been observed. The history is as follows:]

FIG. 11. CASE V. LEATHER-BOTTLE STOMACH DUE TO CARCINOMA (?). Twenty-five minutes. Note small size and dumb-bell shape, very rapid emptying and compensatory dilatation of esophagus.

CASE V. LEATHER-BOTTLE STOMACH DUE TO CARCINOMA (?).—C. M., female, aged sixty-three. The patient had suffered from vomiting for several months; no food in the vomitus, just mucus and apparently bile. The vomiting had become almost continuous and was without relation to the taking of food. It was impossible to obtain stomach contents for a gastric analysis. (The reason for this is very evident in view of the rapid emptying of the stomach shown radiographically.) Wassermann negative.

Roentgen examination: the lower end of the esophagus showed slight dilatation. (Fig. 11.) The stomach was exceedingly small and dumb-bell shaped. (Figs. 12, 13.) The pylorus was gaping so that the entire duodenum and upper jejunum were immediately filled. Moderate dilatation of the duodenum suggested some tendency to com-

pensation for the small size of the stomach. Roentgen diagnosis: leather-bottle stomach —cause not evident.

A confirmatory examination made three days later showed the same appearance. No abnormality of the colon observed.

On account of the continuous vomiting the patient begged for operative relief. March 11, 1921 (two weeks later) a jejunostomy was performed by W. A. Downes. At operation the stomach was found to be greatly reduced in size and capacity, giving a typical leather-bottle appearance. The walls were extensively involved in what appeared to be a diffuse carcinoma. In the middle of the lesser curvature was a contracted area which suggested the site of a previous ulcer. No evidence of secondary nodules in the liver or lymph nodes, so that no material was obtained for microscopic examination.

Further report of this case may be made later.

FIG. 12. CASE V. LEATHER-BOTTLE STOMACH DUE TO CARCINOMA (?). Twenty-eight minutes. Dilatation of duodenum compensating for small size of stomach.

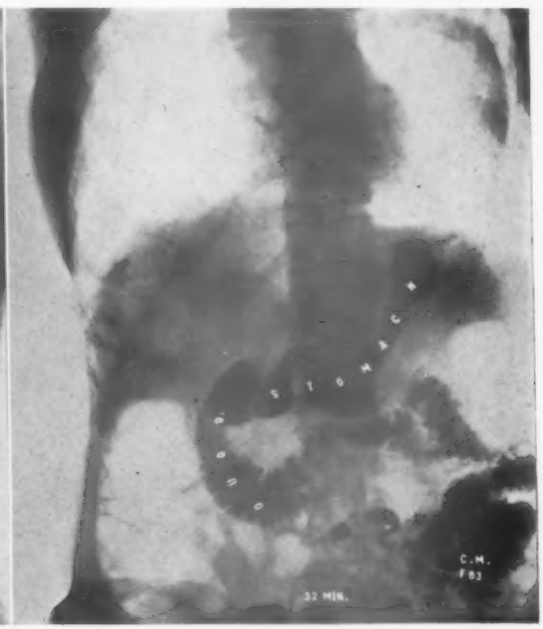

FIG. 13. CASE V. LEATHER-BOTTLE STOMACH DUE TO CARCINOMA (?). Thirty-two minutes. Note dumbbell appearance still persisting.

CONCLUSIONS

1. The cautious roentgenologist, on encountering a case showing the typical appearance of leather-bottle stomach, will do well to report his findings in detail, but reserve his final diagnosis, stating that the case may be one of three things:
   (a) Syphilis of the stomach.
   (b) Diffuse carcinoma of the stomach.
   (c) Fibromatosis of the stomach wall.
2. The terms "linitis plastica" and "leather-bottle stomach" may well be retained as descriptive of this type of deformity of the stomach, but with a full appreciation of its triple nature.

DISCUSSION

DR. A. F. HOLDING. In discussing this paper, we (Jackson Clinic) happen to have a case of linitis plastica hypertrophia chronica, and I thought I would show you the slides and trace the development of this case, which as far as I

know is unique in that it has been under *x*-ray observation since its start. This case was examined first in December, 1919, and a filling defect demonstrated. I reported a "filling defect which was suspicious," and suggested a re-ray. Dr. James A. Jackson and I examined the patient together fluoroscopically. We got a perfect outline of the stomach, so we thought that the defect previously seen was due to spasm or to pressure of the spine, or something like that. There was no tumor palpable. The case was discharged with instructions to report at the end of three months. At the end of eight months, I found the case had gone to the University Clinic, and that they had made an *x*-ray examination. Dr. R. H. Jackson was asked for a surgical opinion, and we asked to see the plates. These plates showed a filling defect, constant, which we thought was carcinoma. At this time, there was a palpable epigastric tumor.

This shows the development of this case—eight months before we found first a filling defect, and then were able to exclude it—for by the administration of antispasmodics, we had a normal stomach shadow—no palpable tumor. Eight months later—large, typical, constant filling defect—palpable epigastric tumor.

The case was operated by Dr. R. H. Jackson, and a pylorectomy done. After taking the tumor out he said it cut rather "funny," that it showed a cheesy consistency, and did not cut like a typical carcinoma, that when he cut through it, it creaked like leather. So the specimen was sent to the Mayo Clinic, and they reported back a typical case of linitic plastica. Through the kindness of Dr. Broders, I have been able to obtain slides and photomicrograph of the case, which are here presented. I am indebted to Dr. Curl for the privilege of showing some of these plates.

Dr. L. T. LeWald. A question has been brought up which is still under discussion by pathologists. For example, Dr. Ewing, I believe, takes the stand that all linitis plastica cases are malignant, with the idea that they are carcinomatous, that if you search hard enough, you will find carcinoma cells. However, other pathologists do not agree with this, and among a series of sixty cases reported by Dr. Lyle, you will find statements like the following: "Linitis plastica, malignant type; linitis plastica, benign type," etc. Case I is running a course toward a fatal determination, but whether due to the gastric stenosis or to malignancy is not definitely known.

SELECTIVE ORGAN STIMULATION BY ROENTGEN RAYS: ENZYME MOBILIZATION

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AMONG the numerous biological phenomena which have been studied in connection with *x*-rays and other radiant agents, the effect on enzymes has received considerable attention. Usually such studies have been made by subjecting enzymes *in vitro* to rays of varying intensity. The opinion has been repeatedly expressed that intracellular enzyme activity must be altered following the raying of tissues, and a number of observations have been recorded which relate to this subject. Thus Heile[1] believed that the destruction of the leucocytes would liberate large amounts of proteolytic enzymes and that these liberated enzymes would then be able to attack other tissues. Neuberg,[2] who worked with the effect of radium on tumors, formulated his ideas in the following manner. The radiation causes a destruction of all the enzymes which have to do normally with the anabolic processes of the cell, while those that bring about autolysis are not altered. He showed that rayed carcinoma tissue autolyzed more rapidly *in vitro* than unrayed tissue. A number of other workers have reported experiments similar in character (Packard, Heile, Wohlgemuth, etc.).

So far no experiments have been reported which deal with the actual demonstration of alterations in the titer of the serum enzymes after *x*-ray or similar stimulation. Under the circumstances we thought it would be of interest to determine (a) whether such an alteration in titer does take place, (b) whether variations in the serum enzymes take place when different organs are stimulated, and (c) the influence of different degrees of stimulation on the alterations in titer.

In our experiments we have used dogs rather than the smaller laboratory animals. The larger serum amounts can be withdrawn from them for study without injury; the normal serum enzyme titers more closely resemble those obtained in the human, and in smaller animals the raying of organ groups is technically much more difficult and uncertain. Even in dogs it is of course impossible to confine the rays to any one organ, so that when the liver area is rayed, parts of the pancreas, the gastro-intestinal tract, etc., will necessarily be included to some extent and the results must be interpreted with this consideration in mind. In our preliminary experiments we used large doses (Coolidge tube, 10 inch distance from the skin, 8 ma., 5 to 8 inch back-spark without filter) for periods ranging from fifteen minutes to one hour. With the shorter periods of exposure we found that raying of the liver and intestinal areas resulted in some mobilization of enzymes, but that following the longer periods the titer of the enzymes diminished. We then proceeded with a filter (4 mm. aluminum) and reduced the time of exposure to the following periods—five minutes, ten minutes and twenty minutes, the latter with and without a filter. When so rayed, considerable alterations in the serum enzymes could be determined depending on the area rayed and on the duration of the exposure.

Our studies on the dogs included the nitrogen secretion, the non-coagulable nitrogen of the serum, the leucocyte and differential count, the coagulation time of the blood, the titer of the serum protease, peptidase, esterase (lipase), diastase, the anti-trypsin, and the complement titer. During the course of

the experiments a number of dogs were used for each regional exposure, but in the accompanying chart the average for two dogs has been used.

Nitrogen Excretion.—The animals were kept in metabolism cages and on a fixed diet. With the exception of the periods following the longest liver exposures there was no apparent increase of nitrogen excretion following the *x*-ray periods in the course of the experiments. Following the twenty minute exposure of the liver area the average nitrogen excretion was, however, increased approximately 60 per cent for a period of four days following the exposure.

Non-coagulable nitrogen of the serum.—This was altered to a considerable extent only following raying of the liver area where an increase of as much as 50 per cent was occasionally determined after raying for ten minutes or more. This increase persisted for several days in such animals. Hall and Whipple [3] in their experiments with lethal *x*-ray doses obtained such increases with considerable regularity.

The Leucocyte Count.—The leucocytic reaction showed considerable differences with the different regions stimulated. In the following tabulation the normal count taken before the *x*-ray exposure is contrasted with the average of the counts obtained for the one-half hour, one hour, five hour, twenty-four hour, forty-eight hour and seventy-two hour periods:

CHART I

	Liver	*Spleen*	*Intestine*
Normal	4,000	10,000	3,000
After 5 min. Exposure	7,600	16,700	3,400
Before	3,200	14,200	3,000
After 10 min. Exposure	5,600	13,400	8,200
Before	3,400	11,400	7,400
After 20 min. Exposure	10,000	11,300	12,900
Before	4,800	13,700	14,300
After 20 min. Exposure (without filter)	8,100	14,300	17,450

In Chart I the effect of the raying on the leucocytes is graphically apparent. It will be observed that following the raying of the liver there resulted a leucocytosis of transient nature; following raying of the intestinal area the effect of raying was a step-like increase until a relatively high leucocytosis (15,000) was maintained. The two dogs used for the spleen experiment commenced with a relatively high leucocyte count (as well as a high serum enzyme titer) and raying did not materially alter the count. The commonly observed leucopenia that follows raying in the human was not observed in this series of animals with the doses that we employed.

Differential Count.—Following the raying of the hepatic area three of four dogs observed showed a well marked eosinophilia. This ranged from 5 per cent to 20 per cent and persisted for a number of days after the exposure. Raying of the intestinal area and the splenic area resulted in general in a diminution of the mononuclear elements and a relative increase in the polymorphonuclear cell forms.

Blood Coagulation.—A number of European observers have recently discussed the increase in coagulability of the blood which they have observed after raying of the spleen. Our observations were made with the capillary tube method and gave us a normal clotting time that varied between three and four minutes. Promptly following the raying of the animals this was usually reduced from one to two minutes, the blood clotting so rapidly that the bleeding of the animals was at times very difficult. In our series there seemed very little difference whether the splenic or hepatic or intestinal area was rayed, the result being apparent no matter what region was stimulated. In studies reported in the following paper it was found that an increase in the thromboplastic substance as well as an increase in fibrinogen occurred after the raying.

The Serum Enzymes Protease.—The proteolytic titer of the serum was estimated by the chloroform method which has been described elsewhere.[4] While open to objections,

it nevertheless seems to give a fair index of the proteolytic capacity of the blood. As will be observed in the chart (the nitrogen digest of the serum is expressed in 1/10 milligrams), raying of the hepatic area increased the serum proteases after the ten minute exposure and the twenty minute exposure. The long exposure when unscreened was no longer effective. Protease appeared in the serum after raying the intestinal area, too, while raying the spleen seemed in general to be followed by a diminution of the originally high titer.

Peptidase.—Peptidase was titrated by allowing varying dilutions of serum to digest Witte peptone and determining the liberation of tryptophan by means of the simple bromine color reaction. Normal dog serum contains practically no peptidase; after raying the liver the enzyme makes its appearance but never to the extent that was observed after raying the intestinal area. Raying of the splenic area was never followed by such mobilization.

Lipase.—Serum esterase was determined by incubating ethyl butyrate with serum and titrating the resulting formation of acid by means of 1/50 NaOH. Moderate doses of *x*-rays seem to mobilize this enzyme after raying the hepatic as well as the intestinal area; raying of the splenic area, on the other hand, seemed to cause a gradual reduction in the amount of lipase in the serum. This was not, however, a constant finding in all of our animals, for in some raying of the spleen was at times followed by a well-marked mobilization of lipase, especially following a single dose of moderate intensity.

Serum Diastase.—The titer of the serum diastase was determined with the Wohlgemuth method of starch digestion by varying dilutions of serum, and the titer is expressed in units (24 hour digestion). Raying of the hepatic area was usually followed by a short sharp rise in the diastase curve. In the chart this does not become apparent because the average for the six bleedings after the *x*-ray exposure was not greatly altered. Raying of the intestinal area did not generally influence the titer, while raying of the splenic area was followed rather by a diminution.

Complement.—The complement titer (hemolytic titer) was followed in a number of animals, but seemed unaffected by the rays in the dosage that we employed. (Not charted.)

Anti-ferment.—Fluctuations in the titer of the serum anti-ferment were quite marked. As a rule the titer increased for a short time following the exposure, then diminished and gradually increased again for from forty-eight to seventy-two hours. The most marked effect followed the more intense periods exposure. (Not charted.)

DISCUSSION

While the clinical development of the *x*-ray and the related radiant agents has been confined largely to the field of diagnosis and local therapeusis, the possibility of remote therapeutic effect has not been uninteresting to medical observers. Among them Edsall and Pemberton [5] endeavored to utilize the effect of the *x*-ray in stimulating autolytic processes by their effort to hasten the autolysis of unresolved pneumonia by means of *x*-ray. Since their publications a number of observers have apparently sought similar applications. Perhaps the work of Manukhine [6] is of particular interest in this direction. Manukhine, aware of the influence that the spleen seems to have in favorably influencing the course of a tuberculous process, found that when he rayed the spleen of tuberculous animals (and patients) the tuberculous process improved. When, on the other hand, he rayed the liver the tuberculous process rapidly extended. He sought to explain the result because of the differences that follow in the leucocytic reaction with the different organs stimulated. While this is not to be excluded, we are nevertheless of the opinion that other factors must be taken into consideration, among them the effect of the serum enzymes which as we have shown in these studies takes place after *x*-ray stimulation.

Other observers besides Manukhine have

taken advantage of the remote effects of *x*-ray stimulation to bring about therapeutic effects. Drey and Losser [7] have but recently called attention to the effect of splenic *x*-ray stimulation on bronchial asthma, an effect first observed by Schilling;[8] Stettner [9] has used the stimulating property of *x*-rays in increasing healing and ossification and has also made the application in the stimulation of glands of internal secretion, as for instance in raying the head to stimulate the hypophysis to promote growth.[10] Stephan's [11] work in studying the effect of splenic raying on the blood coagulating mechanism will be discussed in the following paper.

The regional stimulation of the abdominal organs such as we have reported in this paper may perhaps be of some significance in the study of the intoxications brought about by *x*-rays and similar agents. Using small laboratory animals Denis, Martin and Aldrich [12] found that intoxication was dependent on exposure of some part of the gastro-intestinal tract and they are of the impression that the intoxication is closely concerned with a reduction of the alkali reserve found by them following raying of intestinal areas. Hall and Whipple [3] regard the intoxication as a protein intoxication following injury of the gastro-intestinal mucous membrane. If the effect is in the nature of a non-specific protein intoxication we must keep in mind that some of the remote therapeutic effects occasionally observed may be closely related to non-specific therapeutic results obtained by other means, such as vaccine, proteose, milk or tuberculine injections.

If pathological lesions are to some extent influenced by the serum enzymes it would seem to us possible that through *x*-ray organ stimulation or stimulation by other related agents a means of such therapeutic control is offered. We are of course at the present time unable to state definitely whether the metabolism of the normal cell is altered by the alteration in titer of serum enzymes; but where we deal with necrotic tissue it would seem plausible that an increase of the proteolytic serum enzymes would hasten the removal of such material provided that other factors that influence digestion (hydroxyl-hydrogen balance, anti-ferment concentration, etc.) are favorable. It might seem of interest to keep such enzyme mobilization in mind when studying the remote effects of radiant agents, not only where we have to deal with toxic manifestations (*x*-ray shock, etc.) but also where favorable therapeutic influences are made manifest.

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THE INFLUENCE OF X-RAY ORGAN STIMULATION ON THE COAGULATION MECHANISM

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DURING the experimental observations on the effect of the *x*-ray exposure of the hepatic, splenic and intestinal areas for varying periods of time as reported in the preceding paper, evidence of a change in the coagulation time of the blood was obtained. A number of recent investigators, observing the reduction of the coagulation time following the raying of the splenic area have suggested that measure for therapeutic use in cases of severe hemorrhage. Stephan [1] for instance reports a case of purpura fulminans in a man of forty-five in which a refractory hemorrhagic diathesis was successfully combated early in 1919 by means of deep roentgenotherapy applied to the spleen. Investigations that he undertook in connection with this result led him to state that roentgen radiation applied to the spleen rapidly decreases the coagulation time of the blood *in vitro*, and increases likewise to a considerable extent the amount of coagulating ferment in the blood serum. Radiation seems to have the same effect on the organism as extensive loss of blood. The essential factor that arrested and cured the hemorrhagic tendency was the increase in the quantity of the coagulating ferment, and this was realized by the action of the roentgen rays on the spleen. He thinks they exert a specific functional stimulus on the elements of the spleen other than the lymph follicles. The blood platelet count does not seem to be modified.

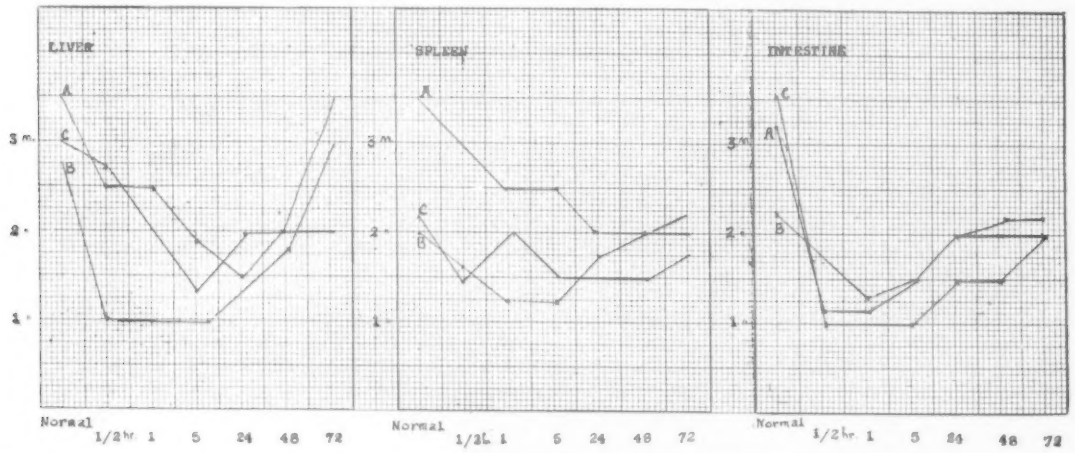

CHART I. COAGULATION TIME OF THE BLOOD AFTER X-RAY EXPOSURE FOR FIVE, TEN AND TWENTY MINUTES.

The coagulation time was shortened sometimes to one fourth even in normal subjects by raying the spleen; the maximum effect was apparent between the second and fourth hours, and then gradually subsided. His clinical and experimental research demonstrated, he believes, that stimulating the functioning of the spleen by roentgen radiant energy must be regarded as theoretically a true physiologic method of arresting venous and parenchymatous hemorrhages. In numerous cases it proved extraordinarily effectual in practice, far surpassing the effect of any medical hemostatics.

Jurasz [2] considers this observation of con-

siderable practical importance in surgery, and recommends that before operative procedures the coagulation time of the patient be determined, and if it is found delayed, that the patient be rayed from fifteen to twenty hours before the operation in order that the coagulation time be brought within normal limits.

As a matter of fact it is probable that any stimulation of the spleen results in this same effect on coagulation. Thus Nonnenbruch and Szyszka [3] found that simple diathermy of the splenic area would appreciably increase the coagulability of the blood in from one to two hours. The effect was, of course, not quite so pronounced as following radiation. Szenes [4] found that the increase in coagulation occurred not only after raying the spleen, but after raying lymphatic tissues in general.

In a more recent publication Stephan [5] takes exception to the work of Szenes, however, for the reason that his observations were limited wholly to the measuring of the coagulation time, not to a study of the individual factors in the coagulation balance. Thus a lowering of the antithrombin content, or an increase in the platelet count might simulate the results obtained when there is an actual increase in the thrombin.

In view of the practical importance of the subject we have made a detailed study of the alterations that occur in the coagulation mechanism following raying of the hepatic intestinal and splenic area. The observations included the following: clotting time; prothrombin; antithrombin; fibrinogen; blood platelets.

Prothrombin and antithrombin determinations were performed according to the method of Minot.[6] Thrombin was prepared according to Howell.[7] Fibrinogen determinations were recorded according to Wohlgemuth.[8] Blood platelet counts were observed by the Wright-Kinnicut method.

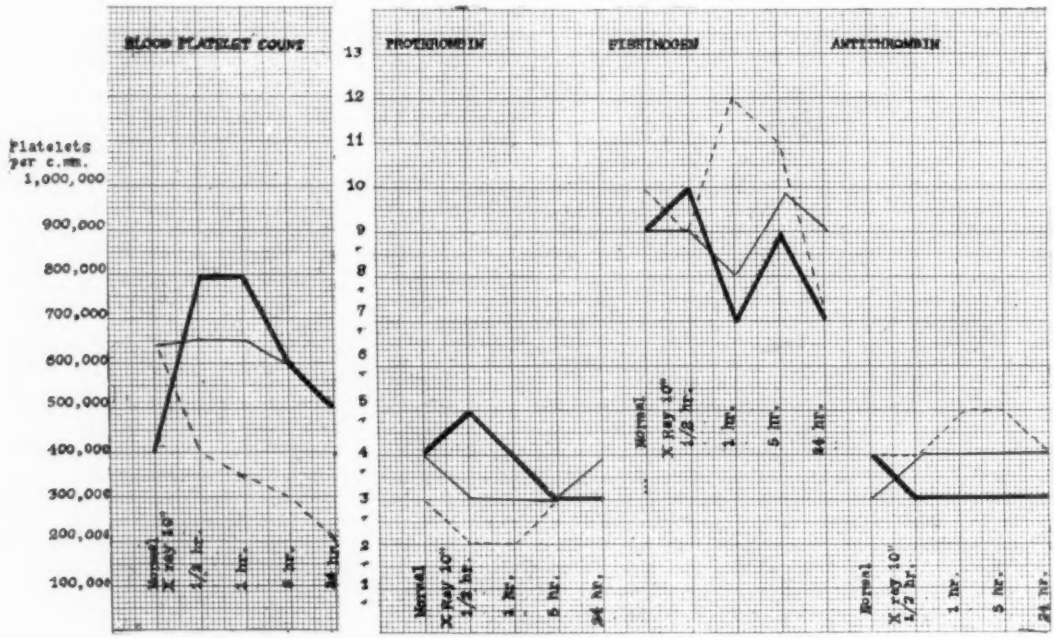

CHART II. HEAVY LINE—Titer after raying hepatic area; DOTTED LINE—Intestinal area; LIGHT LINE—Splenic area.

Dogs were exposed for 10 minutes (Coolidge tube, screened by a 4 mm. aluminum screen, at 10 inch distance, 8 ma. and 5 inch back-spark) over the liver, intestinal and splenic areas. The exposures were made in the morning (serum samples being obtained before) one-half, one, five and twenty-four hours after exposure.

BLOOD COAGULATION.—In studying the coagulation time, capillary tubes drawn out to a uniform diameter were used, the clotting

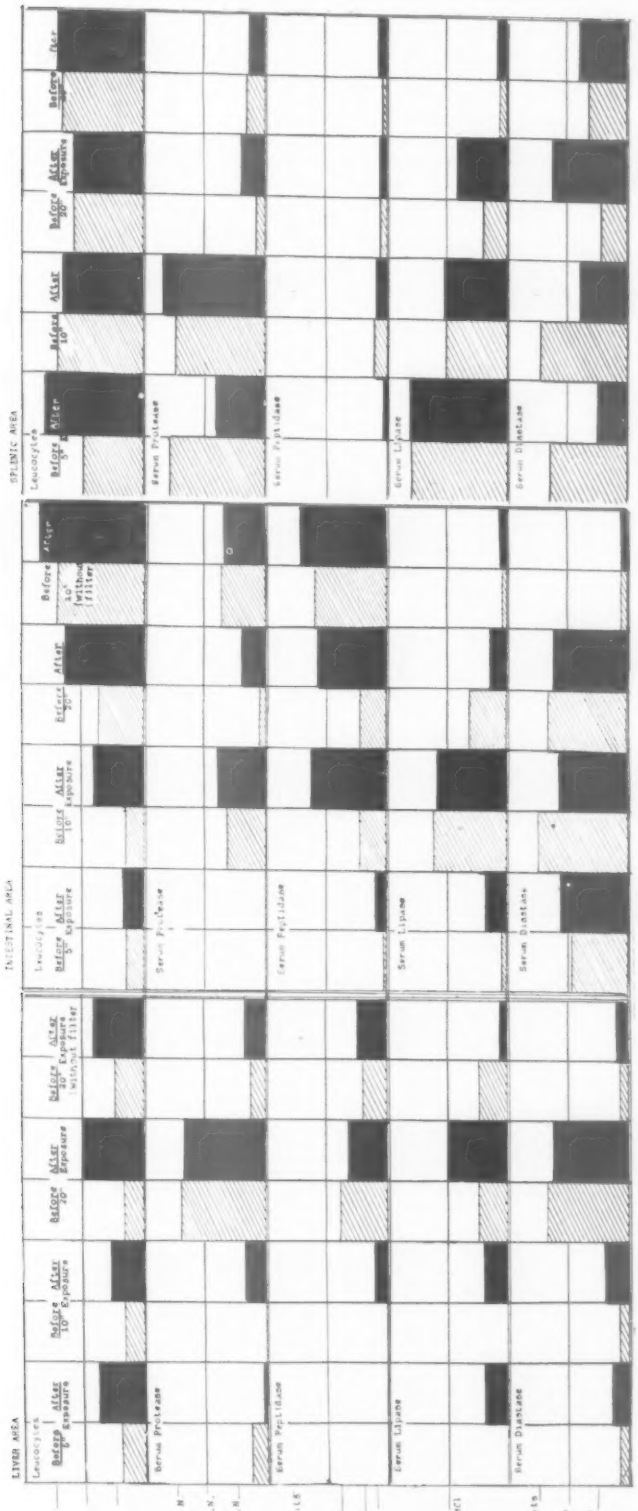

CHART III. Illustrating leucocytic and enzymatic reaction following raying of liver, intestinal and splenic areas in dogs for five, ten and twenty minute periods. The shaded blocks represent the liter before the period of raying, the black blocks the average for the determinations following the raying (serum samples taken ½, 1, 5, 24, 48 and 72 hours after the exposures).

time recorded when on breaking the tube a firm coagulum could be drawn out. In our experiments the most prompt effect on the clotting time seemed to follow raying of the lower intestinal tract; the effect on the clotting time following exposure of the splenic area was more delayed. In the later case, however, the effect on the coagulation especially after longer raying periods was more prolonged. In Chart I the average coagulation time is shown.

In view of the rather decided changes in the coagulation time above noted we anticipated marked alterations in the titers of the coagulating factors in the blood, corresponding to the observations of Stephan. In this we were disappointed. As will be observed in the next chart (Chart II) fluctuations in the various elements of the balance did occur but not to the extent demanded by the marked lowering of the actual coagulation time.

Blood Platelets.—Raying of the hepatic area gave a maximum increase of blood platelets during the one half to one hour period, gradually returning to normal. Raying of the splenic and intestinal areas gave a gradual diminution in the platelet count during the ensuing time periods.

Prothrombin.—Exposure of the liver showed a slight decrease up to the one-half hour sera, with gradual increase in the remaining sera, while the spleen and intestinal exposures showed an increase with a subsequent return to normal. (The curve, Chart II, in which the serum dilutions are charted, represents the inverse of the actual titer of the prothrombin present in the serum. Thus the actual amount following hepatic raying after a slight diminution, was increased, as was also the case after raying the splenic and intestinal areas.)

Antithrombin.—Raying the intestines showed a maximum increase during the one to five hour periods; splenic raying showed a slight increase through to the twenty-four hour sample, while raying of the hepatic area showed a mixiumum increase during the one

Fibrinogen.—The maximum increase in fibrinogen from intestinal raying was noted in the one and five hour period, diminishing to below normal in twenty-four hours. The splenic raying was followed by a decrease with a maximum increase at the five hour period, returning to normal at the twenty-four hour period. Liver raying showed transitory increase with fluctuating decrease and increase to below normal as noted in Chart II.

CONCLUSIONS

1. Raying of the splenic area in dogs is followed by a diminution in the clotting time of blood determined by the capillary tube method.

2. Raying of other areas (hepatic and intestinal) is also followed by similar changes in the clotting time. The mechanism of the alterations in clotting time may differ following various regional exposure. Thus raying of the splenic area was followed by an increase in prothrombin, some increase in antithrombin, a rather delayed increase in fibrinogen, with little alteration of the platelet count. Raying of the hepatic area was followed by a rather considerable increase in platelet count; raying of the intestinal area by an increase in the amount of fibrinogen.

3. Inasmuch as the effect of the *x*-ray exposure is quite prompt the use of this measure in surgical cases as well as in the management of medical cases associated with a hemorrhagic diathesis seems a feasible procedure. The clinical success of the *x*-ray in the treatment of uterine hemorrhage may depend in part on the general effect on the coagulation mechanism.

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AN X-RAY BURN OF THIRD DEGREE FOLLOWED BY RAPID HEALING*

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AN UNUSUAL case of rapid healing of an extensive *x*-ray burn seems of sufficient interest to *x*-ray therapeutists to warrant its formal presentation in detail. Lest the surprising occurrences hereinafter described be doubted by those whose *x*-ray experiences have brought them into contact with similar reactions of unwished for degree with less favorable results, photographic evidence is offered as part of the record.

FIG. 1.

FIG. 2.

Experience in *x*-ray therapy in skin diseases teaches that the first degree reaction is often necessary to bring about a cure in many conditions; it is usually a transitory condition, a reddening or blushing, which soon fades, the skin returning to normal. Occasionally a second degree reaction occurs, in cases in which a first degree change was desired. This often follows an overdose through misjudging the patient's resistance to *x*-ray action. Depending on the size of area involved and the individual's resistance, this superficial skin destruction will be followed by healing which takes several weeks (sometimes months) and disappears, leaving little or no scarring. In some cases such reactions become a serious consideration to the therapist if the healing process be unusually slow. Through accident, an overdose may be so severe as to result in a third degree reaction or burn. This third degree reaction is a far more serious event than the preceding and most often results in a train of developments which gives the *x*-ray therapist immeasurable worry and often mental anguish, as there is so little that one can do for the relief of the condition. The degree of skin and underlying tissue destruction is so great that some such cases will never heal and recourse to skin grafting is necessary. The tissue destruction may extend through the deeper muscles and reach the underlying bone or even go entirely through a part.

An exception to the usual course of events

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in a third degree *x*-ray burn occurred in a case which was being treated for a very extensive blastomycosis of the lower abdomen.

The patient was a colored male, thirty-seven years of age. He was in good physical

FIG. 3.

condition except for an extensive blastomycotic skin lesion. This lesion was of ten years' duration and began as a small "pimple" on the skin at the perineum. It was of very slow growth and gradually spread in anterior and posterior directions, reaching the posterior limit of the median groove between the nates but not spreading over the buttocks; its greatest spread occurred anteriorly from the point of origin over the entire scrotum, over the shaft of the penis, the glans, and it then invaded the skin over the lower abdomen by way of both inguinal folds, spreading about equally on both sides of the body to the flanks at the regions over the iliac crests. (Fig. 1.)

In the ten years of growth the patient had knocked around from doctor to doctor and clinic to clinic but obtained no permanent relief. The lesion continued to spread slowly in spite of all efforts to arrest its progress. He was unable to work and became a public charge. As is characteristic of this fungus invasion of the skin, the edges of the lesion only were the site of the activity; the remaining area already run over by the growth was left a leathery tough hard skin in which all skin pigment peculiar to the colored race was lost and he was seemingly turning a pinkish white. In the zone of activity the lesion itself had much of a cauliflower appearance. This zone was from 4 to 5 cm. in width all along the edges of the involved area.

X-ray therapy was advised by the late Dr. Harris (at that time head of the skin department of the Cook County Hospital) and treatment was begun in September, 1916. In view of the marked chronicity of the lesion and failure of all other therapy to effect a cure, a more than ordinary skin dosage seemed to be indicated. Multiple areas were necessary to cover all the lesion present. The normal skin was protected from the exposure and three circular areas over lower abdomen anteriorly and one over the perineum were radiated, four in all, each three inches in diameter. A formula of 5 milliamperes of current, a 5 inch spark-gap resistance (60,000 volts), at a 7 inch target to skin distance, for five minutes, with 2 milliammeters of aluminum filter, was given. No

FIG. 4.

noticeable changes followed the first treatment. A second dose was given ten days later which was followed in about a week by a noticeable improvement.

Subsequent treatments were given at two weeks' intervals and the lesion continued to improve. After the fifth series the condition was practically healed with but a few spots of activity remaining, which required more treatment. The patient naturally was much pleased at the outcome and relief from his condition. He informed me with much joy that he now, for the first time in ten years was able properly to use toilet paper.

FIG. 5.

FIG. 6.

At this time an enforced absence necessitated that the treatments be given by an assistant whose previous work had been satisfactory. Explicit instructions called for radiating three areas over the abdomen from right to left and the formula to be followed exactly as already described. Area No. 1 was to be given on the right side anteriorly; area No. 2 in the median line anteriorly and No. 3 to be on the left side also anteriorly. Owing to a slip-up in this proceeding, area No. 1 was given which was followed by area No. 2. Then, instead of setting the *x*-ray tube over area No. 3, the No. 1 area was given a second full dose under the impression that this was the area remaining to be treated. Of course this was not recognized at the time.

In a very short time, the second or third day following, a complete tissue break down rapidly developed in area No. 1, and in eleven days the entire abdominal wall, the skin, subcutaneous and muscle tissues, in the exact area treated, about 3 inches in diameter, had disappeared down to the peritoneum. This alarming event naturally caused much concern. The coils of the intestines could be seen through the thin peritoneum which appeared as a more or less transparent veil. Why this thin structure did not also break down is not explained. The patient did not complain of much pain and seemed the least worried of those concerned. We cautioned all those in his ward not to startle him or in any wise cause any sudden muscular action, for it was feared that the thin wall remaining might rupture, through sneezing or other similar violent movement and thus call for an emergency operation to replace some popped-out colon. He was kept very quiet and a sterile dressing kept in place over the eroded area, binding it firmly and very tightly over the hole in the belly wall. We held our breath, prayed much and feared more, slept but little and went about in fear and trembling. No medication of any kind was given and plans were made for a later surgical repair, if possible. (Fig. 2.)

In fifteen days the broken down tissue had increased but very slightly in extent. (Fig. 3.) During the next few days a surprising

change took place and in one week one hardly recognized the area. The edges had filled in apparently with new regrown tissue, the hole had closed and its size was now about one third of the original area. With wonder we daily observed its progress. We had of course discontinued all *x*-ray treatment to the small, still active spots which consequently began to spread. In thirty days (Fig. 4) the burn had made further healing progress, had become noticeably smaller and in thirty-nine days (Fig. 5) no definite evidence of the accident was visible. There was no real scar, and but little puckering or drawing in of the healed-over spot.

The remaining areas of revived blastomycotic growth were subsequently treated by *x*-ray dosage of the same formula as given above, and a complete cure was obtained. No untoward sequelae have occurred since the events here described (three years) and the patient is now working.

Seeking for an explanation of this unusual healing of so marked a tissue destruction, it has been suggested that the area involved was no longer true skin tissue, having been changed by the fungus invasion, and that therefore it responded in a different way from that in which the normal skin responds.

HIRSCHSPRUNG'S DISEASE. REPORT OF CASE

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HISTORY.—Miss F. B., age eight, was admitted to the hospital with the following history. Father is a syphilitic, and mother is now in a sanitarium with active tuberculosis. Patient normal at birth according to mother's statement. At the age of seven months began to have attacks of constipation, which attacks would last for several days at a time. Her parents then observed that patient's abdomen had begun to distend, and for the following three years had only two stools a week. During one prolonged attack of constipation, patient went into a state of coma, which lasted three days. During this time she had involuntary liquid stools. Drastic cathartics were administered and patient regained consciousness. For the past three years child has been given prune juice and various fruits in addition to her regular diet, which has regulated her bowel action fairly well. Recently, however, the attacks of constipation have become more severe, lasting from a week to ten days. She complains of nausea at times, but does not vomit. Patient has no desire to play or exert herself in any way, as it tends to bring on cardiac distress. She has not lost any weight. She appears to be intelligent, and keeps up well with her schoolmates in her studies.

Examination.—On routine examination, child was found to be normal except for the abdomen. The abdomen was uniformly distended. A palpable mass could be indistinctly outlined on the left side. The patient did not complain of any pain or distress at the time of examination. She was put to bed and an attempt made to clean out the intestinal tract. Quantities of fecal matter were passed following the administration of cathartics and enemas. On the fourth day the patient was sent to the *x*-ray department.

Roentgen Findings.—Screen examination. Under the fluoroscope the stomach appeared to be somewhat distended for a child of this age. Peristalsis was very inactive. No filling defects were noted. The cap was visualized. The duodenum appeared to be distended with gas.

Plate Examination.—Plates made soon after the ingestion of the meal showed findings similar to those noted above. Six hour plates showed considerable gastric residue, only a small portion of the meal having

passed into the small intestine, which was crowded over to the left of the median line. (Fig. 1.) Twenty-four hour plates disclosed a large residue in the cecum, the ascending and transverse portions of the colon

FIG. 1. SIX-HOUR GASTRIC RESIDUE. Small intestine crowded over to the left of the median line.

being well outlined. The transverse colon was deep in the pelvis. Plates made at the termination of twenty-four hours showed a small amount of barium in the cecum and transverse colon. One week later patient was again fluoroscoped, and a small cecal retention was observed. She was put to bed and given daily cathartics and enemas. At the end of ten days, she was given a barium enema composed of 1000 c.c. of water, and 180 grams of barium. This was retained without difficulty. Plates made showed the sigmoid and descending colon to be greatly distended, forming a pouch-like mass which filled the greater part of the pelvis and left abdomen. (Fig. 2.)

For two days following the administration of the barium enema, patient passed quantities of fecal matter and barium. Repeated fluoroscopic examinations continued to show the presence of barium in the cecum, ascending colon and sigmoid. One week later the patient was again fluoroscoped and a small cecal retention was observed.

Diagnosis.—On the roentgen findings and history of the case a diagnosis of Hirschsprung's disease was made.

Operation and Results.—After three days of careful preparation, the case was referred to the service of Dr. Rexwald Brown for operation. Through a left rectus incision, a greatly dilated and thickened descending colon and sigmoid were delivered. Owing to the fact that the dilatation extended into the rectum it was found impossible to perform an end-to-end anastomosis. The distal third of the descending colon, together with the sigmoid and proximal end of the rectum, was resected. This portion of the intestine contained approximately two quarts of liquid feces. The colon and rectum were closed by infolding, and a lateral anastomosis made between the two free ends by means of an oblong Murphy button.

FIG. 2. ENORMOUSLY DILATED RECTUM, SIGMOID, AND DESCENDING COLON.

The patient's condition following the operation, and for the first week was excellent, and every hope was held for an uneventful recovery, but on the ninth day she suddenly developed an acute peritonitis. Drainage was of no avail, and the patient expired.

THE DIAGNOSIS OF A BRAIN TUMOR BY PNEUMOVENTRICULOGRAPHY

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IN any large clinic a frequent subject of consultation between the surgeon and the roentgenologist is the question of the existence or the location of a brain tumor.

In only a very small percentage of tumors does the growth cast a shadow on the plate —Dandy in his studies of the subject says 6 per cent. These were tumors with definite calcified areas, and naturally only the calcified portions were visible. Other growths arising from the intracranial structures, being of no greater density than the surrounding tissues, were of course invisible by the ordinary methods of examination. The signs of intracranial tumors so well studied and ably described by other writers are in many cases pathognomonic, but the percentage is still less than one half and the location of the lesion is seldom definite.

Inspired by the work of Dandy we have made an effort in this clinic to follow his technique in a few cases. Our study has been limited to three cases, one child and two adults. In the first case the results were so striking that it seems worthy of report.

A white boy of six years with unimportant previous and family histories exhibited symptoms three years ago which were diagnosed clinically as probable brain tumor, but the roentgenograms gave no evidence and the lesion was never localized. Subsequent course bore out the diagnosis and two years ago an occipital decompression was done with some temporary relief.

FIG. 1. CASE I. BEFORE INJECTION, SHOWING CALCIFIED AREA.

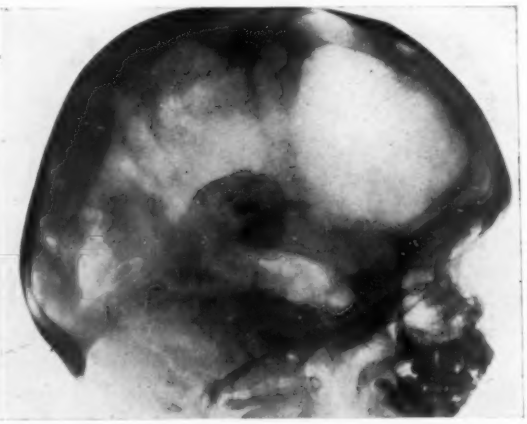


FIG. 2. CASE I. AFTER INJECTION, SHOWING TUMOR SURROUNDING CALCIFIED AREA.

He came to us in an apparently hopeless condition. Radiograms were made in the usual positions. The skull was seen to be unusually large and thin. Mottling of the inner table and changes in the base suggested intracranial pressure. The sutures were wide in the upper portion. Just above the mastoid shadow in the mid-portion of the skull was seen a calcified area of a horseshoe shape apparently in the brain.

With the remote hope of locating an operable lesion the surgeons considered pneumo-

ventriculography. Through a small trephine opening the anterior horn of the right ventricle was entered. A large amount of fluid was released and air was allowed to enter under atmospheric pressure. Radiograms were taken in various positions. The tumor was distinctly seen surrounding the previously observed area of calcification and apparently occupying the site of the pineal body. From its size and location and the poor condition of the patient it was considered inoperable.

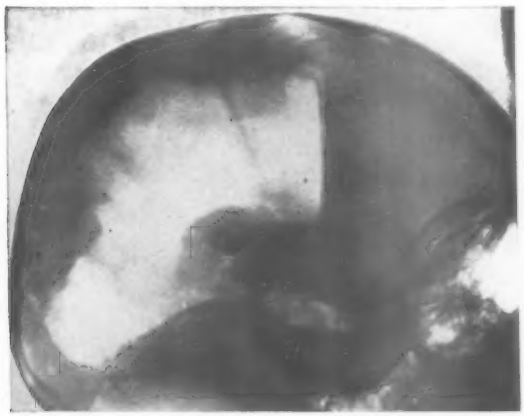


FIG. 3. CASE I. PRONE, SHOWING TUMOR AND FLUID LEVEL.

Following the operation the patient's condition grew worse and on the second day after he died.

It is the surgical opinion that the sudden release of so much fluid and great decrease of intracranial pressure may have hastened the course, although the patient was practically in extremis at the time of the operation.

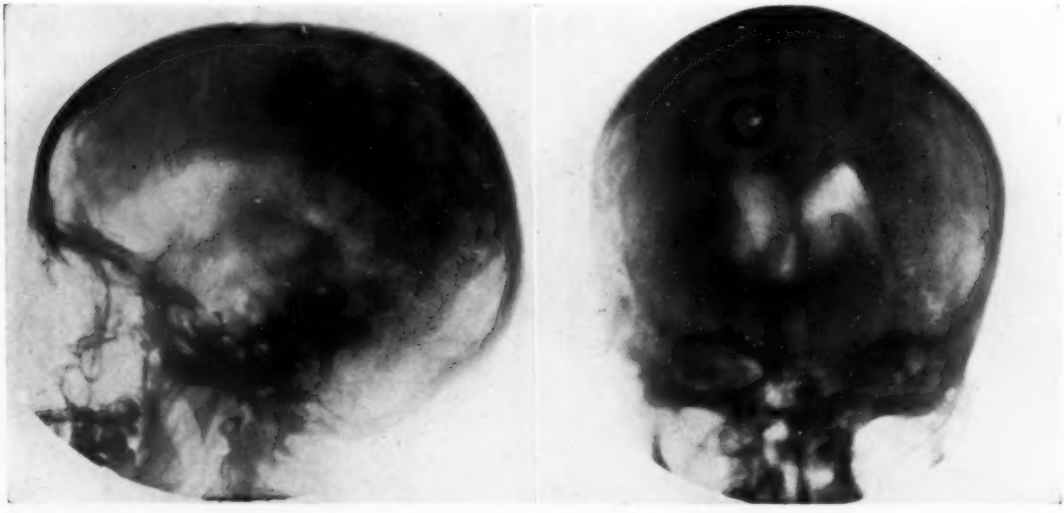
Although the examination failed to help this patient or postpone the inevitable, it demonstrates several valuable points. It shows that intracranial tumors may be made visible. It leads us to believe that in similar cases the examination should be made earlier before the intracranial changes are so advanced. It suggests that where much fluid or great pressure is suspected a measure should be made as accurately as possible of the pressure and the amount of fluid withdrawn, and this restored by an equal amount of gas under an equal pressure.

FIG. 4. CASE I. PHOTOGRAPH OF RIGHT HEMISPHERE SHOWING SECTION OF TUMOR.

At autopsy the tumor was demonstrated identical with the shadow in the plates and

was found to be a teratoma originating apparently in the pineal body, and containing bone, hair and skin elements. The foramen of Monroe and the aqueduct of Sylvius were blocked by the tumor.

cranial picture. This case complained of some headache for a few hours, but there were no disturbing symptoms in either case. These cases suggest to us that the operation may be done in selected cases without harm



FIGS. 5A AND 5B. CASE II. VENTRICLES PRACTICALLY NORMAL IN SIZE. LATERAL AND THIRD VENTRICLES FAIRLY WELL SEEN. POSSIBLE MASS ON LEFT.

The other two cases were adults. In neither case were the findings conclusive. In one the ventricle failed to be injected. In the other there were suggestions of an abnormal mass, but we found ourselves handicapped by our unfamiliarity with the normal intra-

to the patient. We should make ourselves familiar with the normal picture by experiments on the cadaver before we can speak with certainty of small lesions.

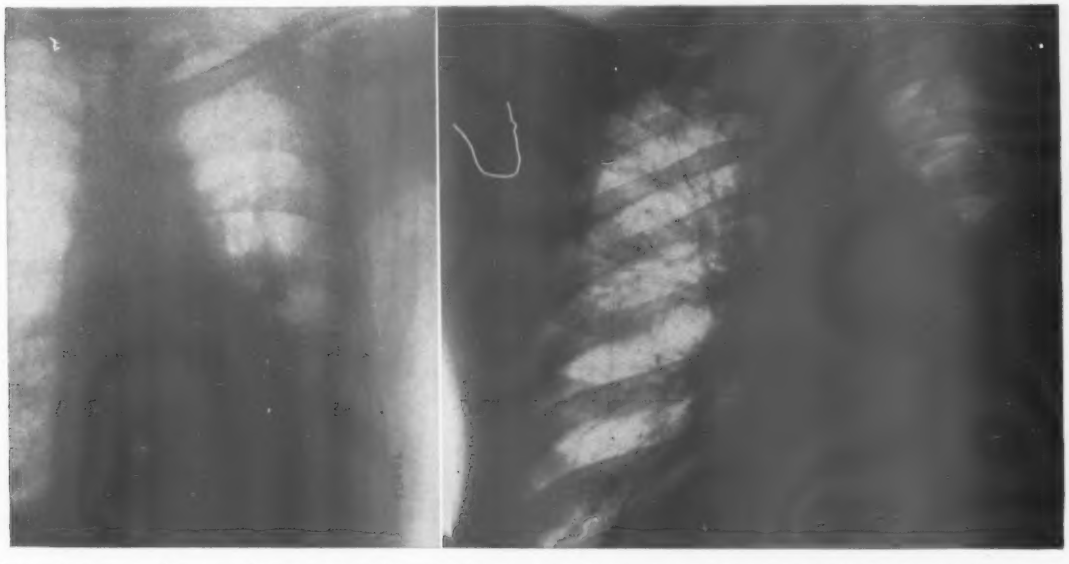
The accompanying prints need little explanation.

FOREIGN BODY IN THE BRONCHUS FOR FIFTEEN YEARS.

By I. SETH HIRSCH, M.D.

NEW YORK CITY

AS illustrative of the relative tolerance of the bronchi to metallic foreign bodies, so strikingly in contrast to the almost immediate reaction which follows the entry of vegetable foreign bodies, because of the tendency of the latter to disintegration and migration (Bégin has called this class of foreign bodies "progressors") the following case is reported:



FIGS. 1 AND 2. PL. A. NO. 220543; SERIAL NO. 70543, JULY, 1920. COIN (DIME) IN LEFT BRONCHUS. DESTRUCTION AND ATELECTASIS OF LEFT UPPER LOBE, FIBROSIS AND ATELECTASIS OF LEFT LOWER LOBE.

M. G., aged forty-five, entered Bellevue Hospital because of hemoptysis. The following history was obtained: Fifteen years ago he was holding a dime in his mouth and someone slapped him on the back and he felt the coin go down. He thought he swallowed it. He coughed for about ten minutes after this, trying to get the foreign body up but without avail. He was not short of breath and went about his work as usual, though for six months following the accident he could feel something "moving up and down" in his chest. During this time he coughed but very slightly. From that time, however, until six months ago he has been practically free of symptoms, with the exception of a very slight cough. There was no shortness of breath, no purulent expectoration. Six months ago he coughed up a considerable quantity of bright red blood. After this he again felt the sensation of something "moving up and down" in his wind pipe for two weeks. During this time the coughing was very severe and he had considerable expectoration with it. The symptoms abated and he was practically well until two weeks ago, when severe hemorrhage brought him to the hospital. From the clinical signs the diagnosis of fluid at the base of the left lung, with fibrosis of the upper portion of the left lung, a possible cavity and a possible aneurysmal dilatation of the aorta was made. Sputum showed presence of fungus but no tubercular bacilli.

The radiographic examination shows an almost complete excavation and atelectasis of the upper lobe of the left lung, with fibrosis and atelectasis of the lower lobe. The heart and mediastinal contents were re-

tracted to the left. The trachea, however, was slightly deviated to the right. The opposite lung showed extensive compensatory emphysema. Between the seventh and eighth ribs, posteriorly, just to the left of the median line, was the shadow of a disc-like metallic body (the coin), its rounded edges somewhat roughened (due to calcarious deposit). The lateral view of the chest showed the coin located posteriorly in the main bronchus of the left lung, and lying in a plane parallel to the sagittal plane of the chest. The esophagus was normal.

That metallic foreign substances are tolerated in the bronchi without severe symptoms is well known in the literature. Such foreign bodies as nails (Collard), coins (Mitchel, Baldwin, Dupuytren), pins and pieces of bone have been found in the trachea and bronchi, where they had been for years without giving severe symptoms. Burch and Lake cite thirty-one cases in which foreign bodies were present in the trachea or bronchi in intervals of one year to sixty, in all of which recovery took place after expulsion or removal. In a case reported by Dupuytren a ten sol piece remained in the bronchus for ten years.

The pathogenesis of the lung lesion is usually the following: bronchitis, bronchopneumonia (peribronchial infiltration), multiple abscess formation, coalescence of the foci with the formation of a large cavity. With this there is fibrosis both of lung and pleura. These lesions were present in the case reported.

The foreign bodies remaining in the bronchi and trachea for a long time become covered with calcareous concretion. Several such cases in which foreign bodies were expelled after a long period, in calcareous form, have been collected by Aronssohn. He cites one case in which a cherry pit in the right bronchus was expelled a year after its inhalation, surrounded by a layer of phosphate of lime, one inch in thickness. (Hirsch, Foreign Bodies in the Alimentary and Respiratory Tracts, *Am. J. Surg.*, January and February, 1913.)

Hemoptysis appears to be a symptom present in the vast majority of such cases. Such recurrent hemorrhages may be the only symptoms for a long period. In many cases, sometimes in spite of a definite history, it is usually ascribed to tuberculosis.

It is difficult to understand how, in these days of abundant roentgen examinations, any foreign body in the respiratory tract can lie undiscovered for any length of time. The paucity of symptoms in a certain class of cases, of which the case reported is an example, may perhaps account for this. But nevertheless cases are being continually encountered in which, in spite of a characteristic history and distinct symptoms, the foreign body has been permitted to remain in the respiratory tract until irretrievable damage has been done to the lung and the removal of the foreign body, even by the skillful bronchoscopist, is no longer a simple matter.

The almost uncanny dexterity with which men like Chevalier Jackson remove the offending bodies from the inner and most submerged provinces of the lung makes one feel that the life of Pope Adrian IV, who died of a fly in his bronchus, would have been saved if Jackson had lived in Rome in the days of that august personality.

During the removal of the foreign body (a ten cent piece, partially encrusted) in the case reported, severe hemorrhages occurred, from which the patient died.

X-RAY FINDINGS IN THE CHRONIC GAS CASES* †

By HENRY C. PILLSBURY, M.D.

WASHINGTON, D. C.

THE close of the war and the return of our troops from France find scattered throughout the country many men who have been subjected to the action of irritant gas at some time during their service. These men will soon return to their civil status, and from time to time will appear at the *x*-ray clinics for the diagnosis of lung conditions. It is confidently expected that no man will be discharged, and later leave the care of the Public Health Service, who stands in need of any further medical treatment for the condition that was caused by his service; but these "gassed cases" will carry with them for a long time the scars caused by the irritant effect of the gas. Unless pathology of this condition is thoroughly understood, erroneous diagnoses may be made, and undue importance may be attached to the various thickenings of the bronchi seen.

Especially must the clinician be on his guard against the diagnosis of tuberculosis in these cases. It is not considered likely that any roentgenologist would make this mistake, as the appearance of the plate is entirely different in the two cases.

The gases that leave behind them a chronic change in the lungs are chlorine, chloropicrine, and especially phosgene. Contrary to the usually accepted opinion, mustard gas is practically without effect on the lungs. In this connection, care must be taken with the history. Nearly always the patient will state that he was gassed by mustard, when in point of fact he had no idea whatever with what gas he was affected. The several gases were used together to a certain extent. Further mustard causes such severe external burns that its action is most impressive. It is an easy name to remember, and in a great majority of cases soldiers will give the history of gassing by mustard quite confidently, although they may have actually inhaled phosgene.

The Research Division of the Chemical Warfare Service has done invaluable work on the pathology caused by the different gases. The description given below is taken almost entirely from their monographs. It is regretted that the masterly and scientific descriptions should be so garbled as has been inevitably the case, in the effort to present the condition as briefly as is consistent with reasonable clearness.

The pathology in the lungs caused by these gases is similar, but presents certain points of difference. Chlorine damages especially the upper respiratory tract, the trachea and the larger bronchi. This gas is a powerful irritant, and strikes that portion of the lung with which it first comes in contact. There is rapid and complete coagulation of the mucous surface; later, after recovery, the epithelium is restored, and the trachea returns to normal, except for the deposition of scar tissue. Rarely the injury may extend to the distal alveoli, causing desquamation of the alveolar epithelium and focal areas of necrosis.

Chloropicrine injures the epithelium of the trachea and larger bronchi, as does chlorine, but to a lesser degree. With this gas, the most notable effect is seen on the medium and smaller sized bronchi. When the bronchiolar wall has been seriously damaged, an active proliferation of fibroblasts occurs, and the bronchial cavity becomes filled with granulation tissue; the final result is an obliterative bronchiolitis, with its consequent atelectasis or localized emphysema. The same result may also occur as a consequence of occlusion of the smaller bronchi by in-

*Published with permission of the Surgeon General, U. S. Army, who is not responsible for any opinion expressed or conclusions reached herein. Board of Publications, Mary Pearson McKnight, Contract Surgeon, U. S. A. Secretary.

†Thesis presented on application for membership in THE AMERICAN ROENTGEN RAY SOCIETY.

flammatory exudate, or by masses of necrotic cells. There is regeneration of the epithelium of the bronchi and alveoli, and organization of the necrotic bronchiolar wall, with scar formation. Focal atelectasis and emphysematous patches may remain.

Phosgene, the most important of all the gases used, in so far as the effect on the lungs is concerned, acts chiefly on the lining epithelium of the smaller bronchi and bronchioles. The upper respiratory air passages escape almost entirely. This gas as it is inhaled has no irritant properties. When, however, the gas reaches the moisture-laden smaller air passages, it is broken up, and HCl evolved. The lining epithelium is destroyed; later the epithelium regenerates, but there is a growth of granulation tissue in the walls of the finer bronchi which causes a thickening of its wall and a peribronchitis. In fact, the outstanding features of the later stages of this condition are the thickening of the walls of the bronchi, and the peri-bronchitis. In a certain number of cases this process goes further, and we find that the infiltration of the walls has extended to the point that the bronchus is entirely occluded. When this occurs, localized atelectasis and restricted areas of emphysema may be expected to be found.

Summarizing the action of the three most important gases, we find, therefore, that chlorine, the most irritant, affects the lining epithelium of the parts with which it first comes in contact—the trachea and larger bronchi. Chloropicrin, which must be broken up into a residue and HCl, only becomes effective after it has reached a part of the lung where moisture can be found—the medium sized and smaller bronchi. Here it causes the same lesions as chlorine. Phosgene is a little more stable than chloropicrin, and is only broken up into HCl and its residue in the smaller bronchioles and alveoli. It is here that it has its effect. It need not be supposed that these three gases are strictly limited in their action to the parts of the lung described; a massive dose or prolonged exposure of phosgene or chloropicrine will affect the larger bronchi as well as the finer ones.

The history is usually indefinite. As a rule these patients entirely recover their strength and their ability to do work. Occasionally, in the more severe cases, there may be shortness of breath on exertion. Nearly always they report to the roentgenologist for examination because of abnormal auscultatory signs picked up by the clinician when consulted for some intercurrent disease.

The *x*-ray plate will show changes closely resembling those found in pneumoconiosis. Adopting the classification used by Pancoast, Miller and Landis in their article published in THE AMERICAN JOURNAL OF ROENTGENOLOGY, March, 1918, we find that these cases of gassing simulate the condition described by these authors as Group 1, the stage of irritation. As in the lungs irritated by the inhalation of dust, we find that the bronchial markings are unusually prominent. Reaching out from the hilus like a bush in the winter time the thickened stalks and twigs of the bronchi extend to the mid-portion of the lung, standing out clear and distinct, with no splotches of exudate to mar or confuse the picture. The bush is symmetrical; it is not confined to one lobe, or to the upper more than the lower portion. It reaches out from the hilus evenly, into all lobes, and is present on both sides. As a rule, the extension is more into the middle lobe on the right side, and into the lower portion of the upper lobe on the left. Because of the overlying heart shadow, the involvement on the right is more apparent than it is on the left. In some instances, added to the outermost twigs, are finer linear markings reaching to the periphery. In the more severe cases, there may be an area or two of localized atelectasis.

Should the gas be chlorine, or should the exposure to chloropicrine or phosgene be unduly prolonged, then the picture is varied by lesions of the trachea and largest bronchi. This condition is differentiated from the early cases of pneumoconiosis in two particulars. The hilus shadow may not be enlarged; its enlargement when present is caused by the chronic bronchitis that sometimes persists. In the second place, there are no small areas of increased density to give

the characteristic mottled appearance of dust inhalation.

The diagnosis from pulmonary tuberculosis is ordinarily not difficult. The distribution, the uniformity, and the absence of areas of consolidation, suffice to make the distinction clear. In certain instances, however, the presence of areas of atelectasis or emphysema, particularly when these occur in the upper lobes, may confuse the diagnosis considerably. Given the history of gassing, a consideration of the pathology that may ensue will assist in making the interpretation less difficult.

THE PRACTICAL APPLICATION OF THE SPHERE GAP TO ROENTGENOTHERAPY*

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CHICAGO, ILLINOIS

IN looking through the literature on roentgenotherapy one cannot help noticing the great variation in spark gap used by different workers in obtaining essentially the same results. It would seem, according to later writers, that such variations should produce results varying proportionally to the differences in gaps used and that, with the same gap, distance, milliamperage and time, essentially equal effects should be obtained, if Coolidge tubes be used. It is well known, however, that this does not occur in practice. What is an erythema dose with one machine is not necessarily the same with another. If we use the same voltage, distance, intensity and time we would expect to get approximately the same effects with transformers of similar type, but the difficulties of working out dosage when changing from one machine to another or when trying to duplicate another worker's results with a given dosage are very real.

Why is one not able, with accurate meters and the Coolidge tube, to obtain as uniform results from a given dosage as with the alkaloidal drugs given hypodermatically? There one expects uniform results in the same type of patient whether a record or a Luer syringe is used provided the same quantity and quality of the drug is used.

In measuring dosage of the roentgen ray we have the same two factors, quantity (represented by milliamperage, time and distance) and quality, depending upon voltage applied to the tube terminals. Wave shape, number of cycles, etc., are not taken into consideration, as there is little evidence at present showing their importance in roentgenotherapy. There is no question but that we get sufficiently accurate quantitative measurements, with the milliammeter, a clock and a tape measure; but what about the qualitative?

The usual method of measuring voltage is in terms of spark-gap between blunt points, sometimes in kilovolts as read on a meter in the primary circuit; and as these seemed much like using an elastic tape measure to measure distance the following investigation was undertaken to determine how great the inaccuracy of the orthodox method of measuring voltage (penetration) was. Before taking up the results of actual measurements made at the tube the drawbacks of the needle gap and voltmeter on primary will be briefly taken up.

In measuring voltage with a needle gap considerable inconsistency has been found by investigators, and this seems especially true of European workers. Quoting J. Lustgarten [4]: "Those that have worked with the gap specified (standard A. I. E. E. needle gap) know that it is difficult to check the American values and even to repeat their own re-

*Read at the Midwinter Meeting, Central Section of THE AMERICAN ROENTGEN RAY SOCIETY, St. Louis, Mo., Feb. 21, 22, 1921.

sults on successive days. One reason for this lies in the effects on the brush discharge of humidity, pressure and temperature, position of the needles with respect to the supports and neighboring objects and the local conditions in the circuit. The brush discharge in the case of needle points always precedes the spark (except at very small distances). A screening by metallic discs at the back of the needles will not prevent humidity, pressure and temperature destroying the standard gap."

To realize this inconsistency one has only to turn to the tables derived by different investigators showing the relation between distance of separation and the breakdown voltage. For example:

U. S. Army *X*-Ray Manual:

40 KV	Gap 3 inches
50 KV	Gap 4 inches

etc., the ration being 10 KV per inch plus 10.

Peek, *Dielectric Phenomena in High Voltage Engineering*, first edition:

40 KV	Gap 2 13/32 inches
50 KV	Gap 3 3/17 inches

etc.

Raper, *Dental Radiography*, first edition:

10 KV per inch.

Knox, third edition, p. 19. Type of gap not stated:

110 KV	4 inches
150 KV	8 inches
190 KV	12 inches
230 KV	16 inches.

This table obviously refers to a sphere gap and shows the difficulty one would have in attempting to correlate his work with the English standards.

The needle gap is also cumbersome if one attempts to use it accurately. Section 245 A. I. E. E. Standardization Rules specifies the following:

"The sparking points should consist of new sewing needles supported axially at the ends of linear conductors which are at least twice the length of the gap. There should be no extraneous body near the gap within a radius of twice its length."

How many roentgen plants are equipped with a gap built according to the above? The average gap as commonly used brings in many sources of error not found in the standard. Peek [2] makes the following statement:

"The needle gap is unreliable at high voltages because, due to the brush discharge and broken-down air that precedes the spark-over, variations are caused by humidity, oscillations, and frequency.

"The needle gap is also inconvenient because needles must be replaced after each discharge; the spacing becomes very large at high voltages, and the calibration varies somewhat with the sharpness of the needle."

"A higher voltage is required to spark over a given needle gap when the humidity is high than when it is low.

"All spark gap curves of whatever form of gap must be corrected for air density—that is, altitude and temperature. For low voltages the spark-over of the needle gap decreases approximately as the air density. At higher voltages the effect becomes more erratic, probably due to humidity."

In using a KV meter on the primary even greater sources of error may be encountered. To quote Chubb and Fortescue [3]:

"The most usual method of measuring the high tension voltage is to measure the primary potential and multiply by the ratio of the transformer. Voltages obtained by this method are generally very much in error due to the distributed capacity in the high tension winding of the transformer, harmonic distortion of the applied voltage wave and the capacity of the terminal bushings and the apparatus to which the high voltage winding is connected. The effective low tension voltage is usually indicated so that there is no measure of the maximum unless a pure sine wave of voltage is applied, there are no appreciable distortions due to the harmonic components of the exciting currents and the capacity regulation can be corrected."

If the usual methods of measuring voltage (penetration) are so faulty, what is the remedy? Engineers have been using a sphere gap for a number of years to measure high voltages and it is well known to be the most

ERRATA

The following corrections were received from Dr. Ullmann after the article had been printed:

p. 197: *Ingenieurmessen* should be *Ingenieurwesen*

p. 198: first column: MacKee formula should read:

$$\frac{\text{gap} \times \text{time} \times \text{milliamperes}}{\text{distance}^2} = 36/64$$

p. 198: second column, table:

In caption, V^1 and V^2 should be U^1 and U^2

Third line, last column, —110 should be —11.

accurate practical method. It is more consistent, the breakdown voltage being affected only to a negligible degree by widely varying conditions of atmospheric pressure, humidity, proximity of neighboring bodies, etc.; more convenient because the terminals do not have to be renewed and it requires less space.[4] Under certain conditions the breakdown of the air gap between equal spheres is very constant and the sphere gap that has already been suggested as a standard for high voltage measurements has been found to be more reliable than the usual methods of test.[3] The results of many tests show the breakdown voltage to be independent of wave shape and frequency when expressed in terms of the maximum value of the voltage wave.[3] Farnsworth [5] quotes Weicher's *Mitteilungen über Forschungsarbeiten auf dem Gebiete der Ingenieurmessen,* Berlin, 1911:

"For sphere gap used over a separation not greater than the diameter of the spheres the influence of the factors of humidity, temperature, pressure, frequency and electrical capacity on the sparking voltage is as follows:

"Humidity—No effect.

"Temperature—Sparking voltage is inversely proportional to the absolute temperature.

"Pressure—Sparking voltage is directly proportional to the barometric pressure.

"Frequency—Within commercial range—20 to 75 cycles—frequency has no effect on the sparking voltage.

"Electrical capacity—No influence."

If the sphere gap is so accurate it should prove any variation of voltage measurements made in estimating *x*-ray dosage. In order to test this the following procedure was carried out in a number of hospitals and private laboratories at Chicago.

The roentgenologist was requested to set his machine for a definite voltage and milliamperage such as he used in therapy and then the voltage was measured at the tube terminals with a sphere gap. Only Coolidge tubes were tested. The findings are as follows:

MACHINE A

Meter reading KV	*Milliamperes*	*Rheo Button*	*Auto Button*	*Gap in inches*	*S.G. KV*
30	25	out	31	2⅛	34.5
35	25	"	35	2⅞	39
40	25	"	40	3½	49
45	25	"	45	4¼	56
50	25	"	50	4⅞	62
55	25	"	55	5¾	71
60	25	"	59	6⅜	77
65	25	"	64	7¼	81
70	25	"	69	7⅝	88
75	25	"	74	8	93
80	25	"	79	8⅞	98
76	5	1	113	5½	60
85	5	2	102	8⅛	77
85	5	10	88	8⅝	89

MACHINE B

Meter reading KV	*Milliamperes*	*Rheo Button*	*Auto Button*	*Gap in inches*	*S.G. KV*
35	25	out	1	3	46
46	25	"	2	4⅝	56
57½	25	"	3	5½	70
47	5	"	2	5	58
58	5	17	3	6	70
62½	5	9	4	6	65
63	2	7	4	6	62
70	5	7	5	6	62
73	5	5	6	6	65
76	5	10	5	7½	73
78	5	12	5	8	80

MACHINE C
No auto transformer

Gap in inches	*Milliamperes High Button*	*S. G. KV*
4½	27	52
5	27	60
5	5	51
6	5	60
7	5	68
8	5	74
	Low Button	
6	5	60
7	5	70
8	5	80
9	5	90

MACHINE D
No auto

Gap in inches	*Milliamperes*	*S. G. KV*
6	3	54
6	5	55
8	3	70
8	5	73
9	2	75
9	6	82

MACHINE E
No auto

Gap in inches	*Milliamperes*	*S. G. KV*
7½ to 8	5	75

MACHINE F
Auto transformer

Gap in inches	*Milliamperes*	*S. G. KV*
6	2	65
6	6	65
8½	5	82

It is easily seen from an examination of the above that there is considerable variation of voltage where one would expect uniformity from the results of his spark gap readings.

In order to get these findings in terms of dosage the following table was made. Column C is the gap between points in inches as measured by the operator. KV is the actual voltage at the tube as measured by the sphere gap. U^1 is an arbitrary unit based on the MacKee formula—

$$\frac{\text{distance}^2}{\text{gap} \times \text{time} \times \text{milliamperes}} = 36/64 =$$

one unit, and represents what the operator thought he was using. U^2 is derived in the same way, using 70 KV instead of a 6 inch gap, and represents what he actually got. 70 KV was taken because it more nearly represents the actual voltage at the tube when the point gap registers 6 inches.

Per cent plus or minus represents the difference between what the operator thought he was using and what was actually used.

	C	*KV*	*U¹*	*U²*	*Per cent*
Machine A	5¾	71	.96	1.01	+4
Machine B, setting 1	6	65	1.00	.93	−7
Machine B, setting 2	6	70	1.00	1.00	100
Machine C	6	60	1.00	.85	−15
Machine D	6	55	1.00	.80	−20
Machine F	6	65	1.00	.93	− 7

From the above table it is readily seen that if an operator using machine D should change to A and give what he had been in the habit of using for an erythema dose he would actually give 30% more. Conversely if operator of A transferred to D and gave what he supposed would be an erythema dose he would actually be using only 77% of the amount.

	C	*KV*	*V1*	*V²*	*Per cent*
Machine A	8	93	1.00	1.03	+3
Machine B	8	80	1.00	.89	−11
Machine C, setting 1	8	80	1.00	.89	−110
Machine C, setting 2	8	74	1.00	.82	−18
Machine D, setting 1	8	73	1.00	.81	−19
Machine D, setting 2	8	70	1.00	.78	−22
Machine E	8	75	1.00	.83	−17

In this table 90 KV was taken as representing 8 inches of back-up and an 8 inch gap the unit for deep therapy.

From the above it can be seen that if what would be an erythema dose on machine D, setting 2, was given with machine A, the patient would receive 1.32 times the dose, while if the readings used on A in producing an erythema were used on D only 76 per cent of the dose would be received.

If dosage were based on kilovolts instead of spark-gap and machines were calibrated so that one knew that certain settings would produce a definite voltage one should be able to change from one machine to another and expect to get the same results without previously testing out the effects on a patient. Also, a roentgenologist could publish the results obtained from a certain dosage with the knowledge that those who attempted to duplicate his results would at least use the same quantity and quality of rays.

There is nothing difficult in using a sphere gap. In fact it is easier as there is no corona and no preliminary sparking. It either fires or it does not, and the difference of a small fraction of a millimeter determines the sparking point. It is easily calibrated to read directly in kilovolts, and the machine once calibrated for the settings in common use, it will only be necessary to recalibrate at long

intervals or when tubes are changed or different control buttons used.

CONCLUSIONS

The present method of estimating quality or penetration by parallel spark-gap between blunt points is exceedingly and unnecessarily inaccurate and is equivalent to measuring tube distance with a rubber band for a tape measure.

The use of the sphere gap in estimating voltage between tube terminals is accurate enough for all practical purposes and is actually easier to use than blunt points due to absence of brush discharge.

If the number of kilovolts used were stated instead of the amount of spark-gap back-up in reporting dosage the results could be duplicated by other workers as easily as in giving drugs hypodermatically and would be an advance in dosage standardization.

I wish to thank Dr. W. D. Coolidge for his advice and assistance in this work.

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THE VALUE OF PROPHYLACTIC X-RAY TREATMENTS*

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IT is rather difficult to determine the value of treatments intended to prevent the recurrence of ailments presumably cured. Nevertheless there are certain indications that justify our drawing definite conclusions as to the results accomplished by the aid of these treatments.

If we know through long experience that in a series of similar cases we may expect a certain number of recurrences, and then find that as the result of treatments carried out this number has been diminished, we are justified in presuming that our treatments have been of some value.

Conclusions reached upon these premises are always open to the objection that perhaps the series of cases, while apparently similar, have in reality not been quite the same. Every surgeon has his own statistics as to his percentage of recurrences in malignant cases operated by him, and they vary in a large degree. Another, and in my opinion, more convincing method of reaching conclusions as to the value of prophylactic treatments, is to take selected individual cases of a character which in the opinion of the operating surgeon would unquestionably result in the recurrence of the lesion operated for. If in these cases we succeed through our treatments in preventing this expected recurrence, we are in a much better position to show concrete proof of the value of the treatments carried out.

The object of this paper is to describe a number of cases which without some interference would have unquestionably resulted in a recurrence, and to show that by a series of prophylactic *x*-ray treatments this expected recurrence has never materialized.

CASE I. Mrs. F. S., sixty-two years old, referred to me by Dr. H. Herman in October, 1911, with a diagnosis of papilloma of the tongue.

Patient had a small growth, about the size of a lima bean, on the edge of the right side, at about the junction of the second and last third of the tongue. There was something suspicious about the appearance of the lesion, and I reported to Dr. Herman that in my

*Read at the Twenty-first Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Minneapolis, Minn., Sept. 14-17, 1920.

opinion we were dealing with an epithelioma and not a papilloma. We decided to remove a small section for microscopical examination, this to be followed by immediate fulguration.

The examination was made by Dr. Harlow Brooks and the lesion was found to be an epithelioma. The fulguration (not dessication) was followed by periodical prophylactic *x*-ray treatments, with the result that up to date (nine years later) there is not the slightest sign of recurrence and the patient is apparently perfectly well.

The patient was treated with a unipolar *x*-ray tube which I devised in 1904.[1] This tube enables us to apply the *x*-ray in immediate contact with the part to be treated. While the output of this tube is rather small, the fact that it can be put in direct contact with the tissues makes it possible to administer considerable *x*-ray at each treatment.

Case II. Miss A. B., forty-seven years old, referred to me by Dr. D. D. Goldstein in November, 1913. Mother died of cancer of breast in 1908. Patient first called on Dr. Goldstein in November, 1913. He found that she had a fair-sized tumor in the right breast, with axillary involvement. He advised immediate operation, but patient waited about two weeks, at the end of which time there was a very marked increase in the size of the tumor.

On operation there was found to be a large tumor of a very diffuse type, with marked involvement of the axillary glands. The sheets of all the blood vessels were involved and they all had to be stripped. The microscopical examination showed the tumor to be a medullary carcinoma of a very malignant type.

The patient followed up her *x*-ray treatments in a very reluctant way. She felt that she was wasting her time and money, so I had to be satisfied with treating the operated side where recurrence seemed most imminent. I succeeded in holding her for about one year, after which time she disappeared. I next saw her in July, 1919 (about six years after her treatment). The right side, where she had the prophylactic treatments, has remained entirely free; but the left side became involved and was operated on by Dr. D. A. Moschkowitz, who found a very malignant diffuse type of carcinoma with marked axillary involvement. I began to treat this side and up to date she has remained free of any recurrence.

I consider this a most instructive case. The original side (right) which was almost entirely involved in a very malignant type of extremely diffuse carcinoma, has remained free up to date (six years) following the prophylactic *x*-ray treatment, while the opposite side, which did not receive any treatments, was the site of recurrence.

Case III. Mr. L. M. E., sixty years old, referred to me by Dr. Edwin Beer in January, 1916, for prophylactic *x*-ray treatments following a nephrectomy for hypernephroma of the left kidney. I will give Dr. Beer's description of this case, as published by him in the *International Journal of Surgery*, December, 1919:

"Mr. E., aged sixty odd years, was operated by the lumbar route for an acute hematuria from the left kidney. The diagnosis of hypernephroma of the left kidney had been made and the tumor mass could be felt in the left lumbar region. If ever a patient looked absolutely hopeless to the surgeon this patient surely did. The pelvis of the left kidney was filled with the tumor mass, which extended through the parenchyma and then had grown through the capsule of the kidney into the perinephritic fat, where a tumor as large as a good-sized fist was growing. The kidney was removed through the lumbar route, but naturally, with the tumor extending from the cortex, it seemed at the time that it would be impossible to deliver the kidney and tumor without spilling the tumor cells." (As a matter of fact, in a letter written to me by Dr. Beer on July 6, 1920, he states that he thought he must have spilled some of the viable tumor tissue.) "After removal of the kidney, all perinephritic fat was carefully excised, and the patient was

[1] *Medical Record*, Sept. 24, 1904.

subjected to intensive *x*-ray therapy. Tonight (four years after operation) the patient presents himself in perfect health apparently. Last spring I made a complete examination and found no evidence of any disease."

Unfortunately I heard recently that this patient had passed away, suffering from a brain lesion, perhaps due to some metastasis in the brain. This I could not make sure of.

CASE IV. Mr. L., forty-five years of age, referred to me by Dr. A. Hyman, in August, 1916, for prophylactic treatment, following an operation for carcinoma of the testicle. I will quote from Dr. Hyman's letter to me (June 7, 1920) in reference to the case:

"Mr. L. was operated on July 19, 1916. In incising through the skin of the scrotum, a large amount of pus with necrotic material was evacuated; all the scrotal layers were edematous. A large tumor of the testicle was found, which had broken through the tunica and had infiltrated the scrotum. The tumor was necrotic in areas and the size of a fist. A typical orchidectomy was done, removing the cord up to the external ring. Pathological report: Carcinoma. In view of the fact that the growth had ruptured through the tunica and had become attached to and had infiltrated the scrotal tissues, I considered the prognosis very bad, and advised either *x*-ray or radium treatment. It is now almost four years since his operation and *x*-ray therapy; the patient, when last examined three months ago, was in excellent condition, with no evidences of local recurrence or metastases. A statement from his family physician, received a few days ago, confirms this report."

This patient, when first seen by me, had a great deal of induration in the operated region—so much so that I even feared at the time that a local recurrence was imminent. He also had considerable induration in the inguinal region, and Dr. Hyman felt quite confident that unless some method was found to prevent it a local recurrence was unavoidable.

CASE V. Mrs. L., fifty-three years old, operated on April 14, 1916, by Dr. Cragin for double cystic ovaries. On section, both cysts showed a cystic and a firmer solid new growth, with part of the capsule invaded by tumor tissue. At the time of the operation, one of the cysts ruptured and the contents spilled into the peritoneum. On microscopical examination, the solid portion showed nests of large cells and a well-marked alveolar arrangement. A diagnosis of adeno-carcinoma was made. This condition was unsuspected before and even during the operation, so the operation was not as thorough and radical as it would have been had the condition been recognized. As part of the capsule was involved and the contents of the cyst spilled into the peritoneum, recurrence was much to be feared.

Prophylactic *x*-ray treatments were carried out for about a year and a half, and there has been no sign of recurrence up to date (four and a half years after operation).

About two months ago this patient was operated upon for a gangrenous appendix. At this time the surgeon carefully explored the pelvic organs and found the uterus freely movable, without the slightest sign of recurrence. She made an uneventful recovery.

I have treated a number of other cases that I think would also clearly demonstrate the value of prophylactic *x*-ray treatments, but my time does not permit me to go into detail about these, as I would like to say a few words in regard to the technique and dosage that I have been using.

Prophylactic *x*-ray treatments, to be of value, must be efficient and must be persisted in for a considerable period. If possible, they should be kept up for about three years after the operation. This is very difficult. Most of the patients will be tired of the treatments long before this period expires, and it can only be carried out if you have an intelligent patient to deal with and if there is a proper cooperation with the operating surgeon and the family physician.

I try to give the treatments in the following routine where I can: First treatment, as shortly after operation as possible; the next

two treatments, at about three weeks' intervals; the next two at four weeks' intervals. This is followed by treatment at six weeks' intervals for the balance of the first year. The second year treatments are given at two months' intervals, and the third year, at three months' intervals.

Of course, the treatments given the first year are the most important, and in the majority of cases you will find considerable difficulty in holding your patients longer than this; but whenever possible, try to get them to persist the full time.

In treating them, be sure to take in as large an area as possible, with special attention to the glandular region surrounding the involved area, also the parts where experience has taught us to expect most probably a metastasis. For instance, in carcinoma of the breast the opposite side should get some treatments—not necessarily as many as the involved side; and, in addition, I think it is advisable to treat the lumbar spine, where many of the metastases will appear.

I think the time will come when these patients will be given a complete *x*-ray bath—in fact, I believe it is quite feasible now. Instead of using small fields, we can have our tube at a distance of about 16 or even 20 inches, take in large areas at a time, and expose the entire body from all directions. I have not tried this as yet, but I am seriously thinking of doing so.

The cases reported above were all treated with the small field cross-fire method.

Dosage.—Try never to produce an erythema in these cases. It unnecessarily frightens the patients, discourages them from persisting with the treatment, and leads to telangiectases and other unpleasant skin conditions. I never use more than three-fourths of my maximum dose at any exposure. I find it more satisfactory to speak of maximum dose, and fractions thereof, than of a definite number of X. Your maximum dose never varies, while the measurements in figures of X generally do.

In standardizing my apparatus I find that the following figures represent my epilating dose—that is, a dose which will produce epilation without an erythema. I have taken this as a standard maximum dose, above which I never go.

Apparatus.—Forty centimeter air-cooled coil, with gas and mercury jet interruptor. Coolidge tube.

Distance	*Spark-gap*	*Ma.*	*Time*	*Filter*
8 inches	9 inches	5	10	4 mm. aluminum and several layers of photographic paper.

In giving these treatments, I use the above formula, except that the time is seven and a half minutes instead of ten. The tendency has been recently to abandon the aluminum filters for those made of copper and zinc. These metals have the advantage of increasing the *x*-ray penetration, but have the disadvantage of requiring much longer exposures. Where you have a large area to cover, this time element becomes of great importance, especially in patients who do not stand the treatments well and who are subject to various kinds of constitutional disturbances. Still, I think that probably we shall have to make the best of this disadvantage. If there is any additional therapeutic value in higher penetrating rays, these patients ought to get the benefit of it.

In closing, I wish to say that I firmly believe sufficient evidence has been gathered by this time to justify our belief in the value of prophylactic *x*-ray treatments. Every operation for malignancy should be followed up with these treatments, and these patients given the additional chance to escape recurrence.

THE AMERICAN JOURNAL OF ROENTGENOLOGY
H. M. IMBODEN, M.D., *Editor* · PAUL B. HOEBER, *Publisher*

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Information of interest to all readers and lists of officers of The American Roentgen Ray Society and The American Radium Society will be found on the two pages preceding Table of Contents.

TWENTY-SECOND ANNUAL MEETING THE AMERICAN ROENTGEN RAY SOCIETY
WASHINGTON, D.C., SEPTEMBER 27, 28, 29, 30, 1921
Headquarters, Meetings and Exhibits: Hotel Washington. Hotels: Hotel Washington and The New Ebbitt.

SIXTH ANNUAL MEETING THE AMERICAN RADIUM SOCIETY
BOSTON, JUNE 6 AND 7, 1921. HEADQUARTERS, HOTEL BRUNSWICK

WASHINGTON MEETING

PRELIMINARY ANNOUNCEMENTS

Plans for the program of the Annual Meeting of the Society next fall are now well under way. Dr. Réné Ledoux-Lebard will give the Caldwell Lecture on the subject of "Deep Roentgen Therapy." It is planned to give a much larger place on the program to papers than has hitherto been done. The plan is to hold the meeting for four days, giving the entire first day to papers on therapy and to have the papers on physics during the forenoon of the second day. This will enable those who are interested only in therapy to leave about the middle of the second day, while those interested only in roentgen diagnosis would not feel it necessary to attend until the beginning of the second day. Those interested in both diagnosis and therapy would probably wish to be present the entire four days.

It is believed that this plan will make the meeting of interest to a much larger number of men. It is requested that those who have papers to present at the meeting communicate with the President of the Society at as early a date as possible.

A. C. CHRISTIE.

The Twenty-second Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY will be held in Washington, September 27, 28, 29 and 30, 1921. Headquarters, meetings and exhibits will be at the Hotel Washington, Pennsylvania Avenue, opposite the Treasury.

Hotel accommodations for members and guests may be arranged at the Washington Hotel and The New Ebbitt. In making reservations state that you are attending the meeting of THE AMERICAN ROENTGEN RAY SOCIETY. Mr. A. Gumpert, Manager of the New Ebbitt, has agreed to see that all those attending the Convention are taken care of. Therefore anybody not getting what he wants should communicate direct with him.

The hotel rates are as follows:

Hotel Washington, every room having private bath with shower, tub and running ice water (European plan only):

	Per day
Single rooms	$5.00 to $7.00
Double rooms (double bed)	8.00
Double rooms (twin beds)	10.00 to 12.00

The New Ebbitt (European plan only):

	Per day
Single room without bath	$2.50
Single room with bath	4.00
Double room without bath, each person	$2.50
Double room with bath, each person,	3.50

Also a number of large suites, both with and without bath, which will comfortably accommodate upwards of four persons. On

these suites they would make a rate of $3.00 per day each person, with bath, or $2.00 per day each person without bath.

For information regarding the program, those wishing to read papers or to show slides at the meeting should communicate direct with the President, Dr. A. C. Christie, 1621 Connecticut Avenue, N. W., Washington, D. C.

For information regarding commercial exhibits and other business matters connected with the meeting, address the Business Manager, Paul B. Hoeber, 67-69 East 59th Street, New York City.

It is hoped to arrange for special trains and cars from various sections. Details regarding this will be announced later.

Annual Meeting Western Section

The officers of the Western Section of The American Roentgen Ray Society are making plans for their second annual meeting. They have selected Portland, Oregon, as the place of meeting, and the time has been set for May 27th and 28th. This time will permit of a continuous trip for the western men who desire also to attend the A. M. A. meeting in Boston.

The Pacific Coast Roentgen Ray Society will meet at the same time and place, the two organizations being the guests of the Portland Roentgen Club, a very active organization of specialists.

The Secretary of the Western Section would welcome a visitor or two from the East with papers or demonstrations, and can assure them of a very enjoyable meeting. Address Dr. Warner Watkins, Box 1328, Phoenix, Arizona.

NEW COMMITTEES

Safety, and Laws and Public Policy

At the last meeting of the American Roentgen Ray Society two important committees were created, a Committee on Safety and a Committee on Laws and Public Policy.

The Committee on Safety is charged with the investigation of all matters pertaining to the dangers incurred in the practice of roentgenology, and recommending measures to increase its safety. This will necessitate an extensive investigation by the committee in order that it may collect data covering the experience of as many men as possible. It is hoped that all members of the Society and readers of the Journal will cooperate with the Committee both by sending to it, voluntarily, any information that may be of value, and by answering any questions that may be sent to them with regard to accidents and injuries, both electrical and *x*-ray, that have occurred in their practice.

The Committee's recommendations with regard to the practical value of safety devices, as well as those for the elimination or lessening of the dangers pertaining to the practice of roentgenology, will undoubtedly be of great value to roentgenologists.

The Safety Committee consists of Prof. J. S. Shearer, Chairman, Cornell University, Ithaca, N. Y., Dr. P. M. Hickey, and Dr. W. D. Coolidge.

The Committee on Laws and Public Policy was authorized by the following resolution which states its purpose:

"During the coming year there shall be appointed by the President at his convenience a committee of three to be known as the Standing Committee on Laws and Public Policy: that it shall be the duty of this Committee on Laws and Public Policy to keep the Society informed as to changes in laws and legal decisions; to cooperate with similar committees from other medical societies and public welfare associations, generally, to the end that this Society shall be found in a proper attitude toward all matters of legislative and public policy which may be found to involve the welfare of the Society or properly to demand the Society's cooperation."

This committee consists of Dr. E. H. Skinner, Chairman, Rialto Building, Kansas City, Mo., Dr. Charles F. Bowen, and Dr. E. A. Merritt.

Any member of the Society who has any matter which he wishes to bring to the attention of this committee should communicate with the Chairman.

A. C. Christie.

SIXTH ANNUAL MEETING THE AMERICAN RADIUM SOCIETY

Preliminary Program

The Sixth Annual Meeting of The American Radium Society will be held at Boston, June 6 and 7. The place of meeting for scientific work will be the Harvard Medical School, the headquarters the Hotel Brunswick. Following is the preliminary program:

Monday, June 6th, 1921

Morning Session

A. Executive Session.
B. Scientific Session.

Treatment of Primary Carcinoma of the Vagina with Radium. Leda J. Stacy, M.D., Rochester, Minn.

Treatment of Uterine Cancer by Radium. Harold Bailey, M.D., Rochester, Minn.

Histologic Changes Occurring in Carcinoma of the Cervix following Radiation, with Special Reference to the Factor of Distance. Charles C. Norris, M.D., and Norman S. Rothschild, M.D., Philadelphia. (By invitation.)

Radium in the Treatment of Carcinoma of the Breast as an Adjunct to Surgery. Ben R. Kirkendall, M.D., Columbus, Ohio.

Radium Combined with X-Ray Treatment in Carcinoma of the Breast. George E. Pfahler, M.D., Philadelphia.

Treatment of Glandular Enlargements with Radium. Russell H. Boggs, M.D., Pittsburgh.

Afternoon Session

A Comparison of Radiation Dosages Attainable by Use of Radium on and without Tumors. Charles H. Viol, Ph.D., Pittsburgh.

Dosage in Radium Therapy. Gioacchino Failla, E.E., New York.

A Comparison of X-Rays with Gamma Rays. William Duane, Ph.D., Boston. (By invitation.)

Hyperthyroidism—Classification — Basal Metabolism in Diagnosis—Renal and Blood Findings—Treatment by Radium. R. E. Loucks, M.D., Detroit, Mich.

Action of Radium on the Blood and Blood-Forming Organs. Isaac Levin, M.D., New York.

Experiences in the Treatment of Nasopharyngeal New Growths. Curtis F. Burnham, M.D., Baltimore.

Treatment of Multiple Papilloma of the Larynx in Children. Gordon B. New, M.D., Rochester, Minn.

C. Short Executive Session.

Monday Evening

Annual Dinner.
President's Address. (Lantern slides.)

Tuesday, June 7th, 1921

Morning Session

A. Short Executive Session.
B. Scientific Session.

Radium in Dermatology. Frank E. Simpson, M.D., Chicago.

Dosage in Superficial Lesions. William S. Newcomet, M.D., Philadelphia.

Treatment of Carcinoma of the Rectum. Douglas Quick, M.D., New York.

Treatment of Prostatic and Bladder Carcinoma. Hugh H. Young, M.D., Baltimore.

Treatment of Malignant Disease of the Bladder. Benjamin Barringer, M.D., New York. (By invitation.)

Treatment of Brain Tumors by Radiation. Henry K. Pancoast, M.D., Philadelphia.

Tuesday Afternoon

Clinic at the Huntington Memorial Hospital, by invitation and under the direction of Dr. Robert Greenough, Director of the Hospital.

CANADIAN RADIOLOGICAL SOCIETY

Notice of Change of Meeting Place

The Annual Convention of the Canadian Radiological Society will be held this year in conjunction with the Ontario Radiological Society at Niagara Falls, Ontario, May 31 to June 4, inclusive. Members of the C. R. S. will please take notice of this change.

An invitation is extended to all members of the profession to be present, as the program to be presented will well justify the time spent.

L. K. Poyntz, Secretary-Treasurer.

The Third Congress of the Italian Society of Medical Radiology

The Third National Congress of Radiology took place in the Institute of Electrotherapeutics and Radiology in Rome, October 28 to 30, 1920. It was well attended by radiologists from all parts of Italy. The exhibits of radiological apparatus were large and of great interest.

The opening speech at the meeting was delivered by Prof. Ghilarducci, in which he very ably demonstrated the progress made by Italian radiology both from a scientific and industrial standpoint, and showed that they have been able to maintain a place equal in importance to that of other countries.

Prof. Bertolotti of Turin also delivered an interesting lecture on radio-activity in biology and chemistry.

Prof. Perussia (Milan) discussed the radiological researches of the heart and large vessels, extensively illustrated with clinical and radiological records of personal study.

Prof. Ponzio (Turin) then discussed fully the most recent physical and biological discoveries of radio-therapeutics and the practical results. His statements were strengthened by a large personal experience in the actual state of the therapeutics of cancer. This subject was discussed at length by the leading clinicians.

The program also included numerous other talks of most appealing interest showing fully the activity and scientific value of Italian radiology.

Subscribers to The American Journal of Roentgenology *visiting New York City, are invited to make the office of* The Journal (*69 East 59th Street, New York*) *their headquarters. Mail, packages or baggage may be addressed in our care. Hotel reservations will gladly be made for those advising us in advance; in this case, kindly notify us in detail as to requirements and prices. List of operations in New York hospitals on file in our office daily.*

BOOK REVIEWS

THE RADIOGRAPHY OF THE CHEST, VOL. I. —PULMONARY TUBERCULOSIS. By Walker Overend, M.A., M.D. (Oxon) B.Sc. (Lond.) Pages 120; 108 Illus. Price $5.00. C. V. Mosby Company, St. Louis, 1920.

This is a book of moderate size containing ninety-nine radiograms and nine diagrams. The first chapter deals briefly with technique and the radiographic appearance of the normal chest. The author then discusses the classification of lesions and gives his own, which is a most rational one based on the clinical course and the radiographic findings.

The author, who is evidently a clinician as well as a radiographer, gives a brief digest of the history, physical examination, clinical diagnosis, and in some instances, the post-mortem findings with each radiogram. The arrangement of text and illustrations is not altogether good, for in many instances the notes and radiograms of the same case are several pages apart, making it inconvenient to consult the radiogram while reading the interpretation of the same.

The illustrations are generally good, but in some cases the entire pulmonary area is not shown.

In the last chapter there is a brief discussion of various topics, such as the relative value of clinical and radiographic examination; incipient tuberculosis; tuberculosis in the great war; the heart in pulmonary tuberculosis, etc.

While not a profound exposition of the subject, this work of a combined clinician and radiographer contains material which should be of interest to both the internist and the radiographer.

JOHN G. WILLIAMS

TRANSLATIONS & ABSTRACTS

GREENOUGH, ROBERT B., Boston. The Treatment of Tumors by *X*-Rays and Radium. (Read before the Fifth Congress of the International Society of Surgery, Paris, July 19 to 23, 1920.)

After speaking of the limited knowledge concerning the biological action of radium, the writer discusses the results of radiation of living tissue, which may be enumerated as follows: "(1) Living tissue may be destroyed *en masse;* (2) Growth may be temporarily inhibited; (3) The rapidity of growth may be stimulated; (4) The manner of growth may be modified."

While massive destruction of a complex tissue demands a dose of radiation sufficient to kill the cells of the different types of the area involved, the effects of stimulation, inhibition and modification of growth may be exerted upon individual cells and individual types of cells in the tissue area exposed to radiation, depending upon the dosage, the susceptibility of the cells to radiation, and doubtless upon other factors of which we have insufficient knowledge at present. In the treatment of non-malignant disease and for palliative (non-curative) treatment of cancer, all of the cells exposed need not be destroyed. But to cure cancer by radiation, the exposure must be shown to be 100 per cent efficient in destroying the disease, or recurrence is to be expected.

The massive destructive effect of the lethal dose of radiation is used in the non-metastasizing carcinoma of the skin in both the squamous and basal-celled varieties. It is also used in some of the metastasizing forms of cancer where the removal is impossible. Here the insertion method by the use of the bare tubes of emanation or of the needles holding radium salts or emanation at their tips, has proved effective in producing massive destruction. This method has been employed safely near the surface of the body where normal suppurative processes and their discharges may take place without the risk of deep and dangerous infection. Burying tubes of emanation in deeply situated tumors has proven unsatisfactory, either because the dosage has been too small to be effective or a degenerative process has resulted with secondary infection that made surface drainage necessary. For the treatment of certain malignant tumors on the surface of the body where operative removal is impossible, or in combination with operation, when the operative procedure alone was insufficient, the insertion of tubes of emanation with the resulting massive destruction, finds a field of great usefulness.

As the absorbed rays rather than the penetrating rays produce the greatest effects upon living tissues, it is probable that the beta rays are the most concerned in the production of massive destruction with the radium. For this reason massive destruction is produced only in close proximity to the source of radiation.

The phenomenon of temporary inhibition is shown by the fact that cells exposed to radiation for a certain time remain quiescent for a considerable period, only to awake to active and continued growth after the radium effects have passed away. The time before activity begins again is variable, in some cases several years.

That small doses of radiation produce a stimulant effect upon growth is generally conceded. It is impossible that one dose of radiation should contribute a constituent of growth that was previously lacking as would be the case if a plant or an animal were supplied with a greater quantity of light, heat or moisture. The primary inhibition of growth followed by the later increased rapidity of cell division would appear to justify the assumption that some damage was done by the radiation and as a result the normal processes in response to injury were excited.

In addition to the effect on the tumor, there is an effect seen in the normal tissue surrounding the diseased area. The earliest observable histological changes after radiation are a new growth of the cell elements in the blood vessels and connective tissue. It is impossible to state how much is due to radiation and how much to the natural processes or inflammation and repair excited by the damaged tumor tissue. There is, however, a marked new growth of connective tissue before any recognizable change in the epithelial cells is seen.

The modification of growth resulting from

the radiation of living tissue depends upon the tissue investigated to a great extent. Normal tissues may be made abnormal, and developing embryonic cells may be made to develop in an abnormal manner. This ability of radiation is shown in the clinic in its application to the relief of benign skin lesions such as papillomas and keratoses. In these the destructive effects are not needed or desired. After a mild reaction the deeper cells which were formerly growing in an abnormal manner begin to grow more normal. The abnormal cells are cast off and the lesion heals without a scar. While this action is of greatest value in the treatment of non-malignant lesions, it can be counted upon but little in the attempt to eradicate malignant disease. No modification of growth of cancer cells short of death and destruction of every cell is sufficient to cure the patient of cancer.

The so-called "selective action" of radium upon tumor tissue is next considered. Some benign lesions such as papillomas and keratoses, which yield to the "modifying" effects of radium without the destructive effect, are of the class of so-called "precancerous" lesions, but this does not permit us to presuppose a similar reaction when dealing with cancer tissue.

Different tissues show a variation in sensitiveness to radiation. Lymph-adenoid tissues and those of the ovary and testicle are especially sensitive. Certain tumors of lymph-adenoid tissue, such as malignant lymphoma (Hodgkin's disease) and lympho-sarcoma appear to exhibit a definite and positive sensitiveness, in that when they are first subjected to deep radiation, the tumor masses shrink and occasionally disappear, without undue damage to the normal tissues overlying. But it has been the experience of the writer, that the changes are temporary, and although a recurrence of the tumor masses in the same or in other lymph nodes may again react to radiation, sooner or later the sensitiveness is lost. In myeloid leukemia, profound changes in the blood picture, in the size of the spleen, and in the patient's comfort result from deep radiation of the spleen, but again the improvement is temporary. These two diseases are often evoked as evidence of the selective action of radium. This action, however, is one of modification of growth, or even possibly of stimulation of certain types of tissue, rather than a destructive effect.

The cells of the ovary and testicle are, again, notoriously susceptible to radiation. Ovarian function and menstruation can be brought to an end by intra-uterine applications of radium, and with all of the symptoms of the menopause. Azoöspermia has been frequently found in male *x*-ray workers, although there is reason to believe that recovery from this condition may subsequently occur when exposure ceases.

When cancer is superficial and accessible to direct radiation of any desired dosage, either by surface applications or by insertions, it can often be permanently destroyed. In no case of actual cancer, however, has the writer seen success in this purpose without the production of a destructive lesion, and in many there is a failure to destroy the disease entirely. In some cases, as when a basal cell carcinoma involves the bones of the face or a carcinoma of the tongue extends into the tissues of the floor of the mouth, the cancer tissue seems to be more resistant to radiation than the normal issue in the vicinity. In these cases, at least, no specific sensitiveness is manifest.

Advanced cases of cancer of squamous cell or glandular origin which have extended to the regional lymph nodes are frequently subjected to treatment with radium. The enlargement of the regional nodes is commonly accepted as evidence of extension having taken place. However, it must be remembered that other causes for the enlargement of the lymph node exist and that it is not at all uncommon to see an inflammatory process in regional lymph nodes due to the ulceration of the primary carcinoma. Even in the presence of a certain amount of infiltration of cancer cells, inflammatory changes may occur and lead to fluctuation in the size of the lymph nodes far too rapid to be interpreted as being due to cancer growth alone. In almost every fatal case of carcinoma of squamous cell or glandular origin extension of the disease into the regional lymph nodes ultimately takes place. In none of these cases has the writer seen a permanent destruction of the disease following radiation. Shrinkage in size of a large node is observed, but he is inclined to attribute this, when it occurs, to a change in the accompanying inflammatory process rather than to a destruction of cancer tissue.

Cells engaged in mitotic division are generally believed to be more sensitive to radiation than resting cells. The large number of

mitotic figures is a characteristic of cancer tissue. It is not unreasonable to suppose that a part, if not the greatest part, of the supposed sensitiveness of cancer tissue to radiation is dependent upon the number of cells actually undergoing mitosis during the period of exposure. If this is so, a fractional destruction of the tumor only can be expected as a result of repeated deep radiation, for during each exposure only those cells then in mitosis would be affected, and a diminishing but constant residue of unaffected cells would always remain to awaken into activity and grow at some subsequent time and produce recurrence. It must be recognized that there is abundant evidence that repeated exposure to radiation produces a gradual loss of sensitiveness on the part of the tissues exposed, so that the attempt to accomplish a fractional destruction of tumor tissue by deep radiation is by this fact, also, made more difficult. The clinical observations of the result of deep radiation on cancer tissue are in accord with this theory, for although inhibition or retardation of growth may be observed, the destruction of the tumor and the cure of the disease are not accomplished.

In general, the experience in the clinic and in the laboratory has shown that the massive destructive effect of radiation (by direct application) is necessary for the cure of the disease.

While certain tissues show a sensitiveness to deep radiation which is of value in the treatment of non-malignant disease and in the palliative (non-curative) treatment of malignant disease as well, the cure of cancer (estimated in surgical terms on a three to five year basis) is not accomplished without the massive and total destruction of the tumor by the direct application of the source of radio-activity.

K. F. Kesmodel.

Quick, Douglas. The Combination of Radium and the *X*-Ray in Certain Types of Carcinoma of the Breast. (*Surg., Gynec. & Obst.*, Vol. xxxii, No. 2, Feb., 1921.)

The writer reviews the existent literature briefly, and quotes some interesting early results. He notes that in the past, radium and *x*-ray have not been sufficiently combined. He describes the technique in use at the Memorial Hospital for burying emanation tubes in the tissue; presents an outline of the histologic changes which follow such a procedure and which furnish a rational basis for radium therapy. He thinks that the results following the burial of small emanation tubes (2 or 3 mc.) are better than those following the same total dosage delivered in a shorter time. Filtration, in this method, is through a thin glass wall only, and this permits the use of nearly all of the beta radiation—a very important factor. Subsequent *x*-ray treatment is carried out as though no radium treatment had been given. During the past two and one-half years, 78 cases of carcinoma of the breast have been thus treated at the Memorial Hospital. Of these, 7 show complete regression, and have remained well for periods of from three months to two years; 21 cases show a partial regression, and are still progressing (no case in this group has been observed less than five months); 24 cases showed temporary benefit; 19 of these have died, but without lighting up of the original process; 10 cases showed no improvement (these were far advanced cases with widespread metastases); 9 cases were not followed; 7 cases have been under observation too short a time for any report; 12 of the foregoing cases are reported in detail, with micro-photographs illustrating the histologic changes occurring; 58 of these cases were treated for recurrences and metastatic growth; only one of these was operable. He notes that radium seems to control the pleural pain better than *x*-ray. He concludes that the *x*-ray is useful in the treatment of every case of mammary carcinoma; that radium may be combined with *x*-ray to great advantage in a certain number of cases; that radium is useful mainly in flat or bulky recurrences, axillary involvement, inoperable primary cases, and in cases refusing operation; and that radium and *x*-ray may convert an inoperable case into an operable one at times.

Lowell S. Goin.

Baejter, F. H., and Friedenwald, Julius. Roentgenological Aspects of Lower Right Quadrant Lesions. *Am. J. Med. Sc.*, November, 1920, clx, 639.

The importance of lesions of the right lower quadrant is quite evident. Among the most frequent lesions occurring in this locality may be mentioned:

1. Appendicitis.
2. Incompetent ileocecal valve and ileal stasis.
3. Dilatation of the cecum with retention.
4. Adhesions and angulations.
5. Ulcerations due to tuberculosis.
6. Ulcerations due to carcinoma.

Both bismuth meal and enema are employed. The ingested meal should reach the cecum in five to eight hours, according to the meal employed. Delay in the passage of the meal may be due to dilatation of the cecum, to ptosis or adhesions, to ileal stasis and angulation, ulceration or carcinoma. A bismuth enema, given in the knee-chest position, is also of advantage in studying lesions of the right lower quadrant.

1. *Appendicitis.*—Acute appendicitis may be more accurately diagnosed by filling the cecum to localize the site of involvement and then (in certain instances where the onset of a lower right pneumonia is preceded by symptoms simulating appendicitis) to rule out involvement of this organ by showing the absence of a painful point over the cecum or any limitation of mobility.

Chronic appendicitis: The appendix can be examined only if the lumen is potent and will admit bismuth; otherwise it cannot be visualized. The specific technique emphasized by Case for examination of the appendix is as follows:

(1) Examination of the patient on the horizontal fluoroscope. The tube must be under the table and the screen over the abdomen, to insure the proper examination.

(2) The abdomen must be palpated with the gloved finger or a spoon for localization of a point of tenderness.

The time of examination is of importance. In six hours the cecum fills, and under palpation the appendix may fill. From then on until the bowels are empty it may be visible. When the appendix remains visible for more than a day or two after the bismuth examination it is a dangerous appendix. The bismuth-filled appendix has been noted weeks after an examination. Where there is no local tenderness on pressure, appendicitis can usually be excluded. Where the cecum is limited in motion there is always the possibility that this may be due to inflammation even if the appendix is visualized and not tender. The frequency of visualization of the appendix with bismuth meal varies with different men—35 to 90 per cent. Not every visualized appendix is abnormal. The mere filling of the appendix does not necessarily indicate pathology. When it is curled up, kinked or bound down it probably is pathological.

The stomach is often pulled toward the right lower quadrant due to omental adhesions. As a reflex condition chronic appendicitis may give rise to a picture similar to that of duodenal ulcer; gastric and duodenal hypermobility, with a definite filling defect of the duodenal cap.

2. *Incompetent ileocecal valve and ileal stasis.*—In one sixth of 3000 cases examined by Case incompetency of the ileocecal valve and ileal stasis was noted. Bismuth meals which after twenty-four hours had completely left the ileum were found at thirty-six and forty-eight hours to have regurgitated through an incompetent ileocecal valve into the ileum. The patient should be on his back on the horizontal fluoroscope. The rectal point should be inserted not more than one or two inches. The container of the barium enema should never be elevated more than two feet. Ordinarily 1200 c.c. (100° F.) will fill the colon without causing irritation. The cecum must be well filled and palpated under the fluoroscope. Plates should be made with the patient in the prone position. When a bismuth meal is given it collects in the terminal ileum in about four hours and leaves in eight to nine hours. Delay in passage may be due to spasm, incompetency of the ileocecal valve, bands of adhesions, displacement, prolapse or tumors; dilatation of the terminal ileum points to obstruction.

3. *Dilatation of the cecum with retention.*—The ingested bismuth meal appears usually in the cecum in from seven to ten hours. Delay in passage may be due to dilatation and retention of cecum. This may be associated with constipation, appendicitis, sub-acute inflammatory lesions, or enteroptosis. It is not the position of the cecum which is most important but the function of this part of the bowel. The constipation associated with this condition may be very marked and on operation the retained fecal material may cling closely to the walls of the cecum leaving bleeding areas when separated, showing evidence of a subacute infection.

4. *Adhesions and angulations.*—Angulations

and kinks occurring in the right lower quadrant are often due to adhesions either from appendiceal disease, pelvic inflammation or some local inflammatory process. The delay in the passage of the bismuth will give a clue to this.

5. *Ulcerations from Tuberculosis.*—The clinical picture of intestinal tuberculosis is of little aid in early cases. The roentgenographic examination may give definite information. The most constant finding is intestinal hypermotility, the entire meal being discharged in twenty to twenty-four hours; this may be with or without gastric residue. A spastic condition of the bowels affecting especially the cecum and ascending colon is noted and often irregular filling defects can be seen.

6. *Ulcerations from carcinoma.*—There is in this condition a large irregular constant filling defect of the cecum. Filling defects from adhesions and fecal contents must be carefully differentiated by re-examination at a later date.

In conclusion, the *x*-ray examination should be looked upon as an aid in the diagnosis of the lesions above indicated. The possibility of error is so great that mistakes will necessarily be made. If the roentgen diagnosis is diametrically opposed to the clinical and all other findings it is probably wise to adhere to the clinical interpretation.

L. R. S.

HERNAMAN-JOHNSON, FRANCIS. The Use of *X*-Rays as Immunity-Raising Agents before and after Operation for Cancer. (*Brit. Med. J.*, June 12, 1920.)

The knife may be a means of disseminating stray cancer cells. If before this occurs we can bring about either a weakening of the malignant cells or an increase in the resistance of the body tissues, or both, the chance of successful colony-formation by the parent growth will be lessened. Experimental research has shown that mouse cancer which has been exposed to radiation is grafted into fresh tracts with difficulty or not at all. Clinical evidence supports this fact as applied to man. The *x*-rays act as much by their stimulating or regulating action upon the body as by their depressing effect upon cancer. Embryonic cells are injured or destroyed by doses of radiation which have little or no effect upon the normal tissue. The general stimulating and regulating action of the *x*-rays is of more value than their specific effect upon the pseudo-embryonic cells. The immunity produced by *x*-rays is partial and non-specific. It is not proven that that resulting from the use of radium is any different. Pre-operative treatment should be given. The healing of the wound is not delayed and the only argument against such a procedure is that it delays operation for two or three weeks. This argument, to be valid, implies that the cancer, though improving visibly, is invisibly spreading in depth. This does not occur. If immunity to cancer can be raised by pre-operative raying, we should obviously carry out raying after operation. So long as we are not dealing with actual recurrence, we should be careful to give too little rather than too much. The fact that small doses increase the immunity to cancer and that large ones decrease or abolish it must be kept in mind.

LOWELL S. GOIN.

MARTY, L. A. The Modern Treatment of Malignancies. (*J. Missouri Med. Assn.* Vol. XVII, No. 7.)

In the United states 65,000 people died of cancer in 1918; 200,000 people are suffering at all times from this condition. We are no longer justified in "cutting it out" and allowing the percentage of recurrences to be high and the mortality what it is at present. Only the man doing *x*-ray work and radium therapy will be able to do work that is fair to the patient, for specialists are not made over night in this more than in any other special branch. Breast cases, for example, should have preliminary raying to block the lymphatics and lower the vitality of the malignant cells. A massive dose should be delivered into the wound before closure of the flaps and post-operative raying should be begun as soon as the patient has recovered from the shock of the operation. The axillary and clavicular regions, and in fact the entire chest should be rayed. The same applies to malignancy elsewhere. In cancer of the pelvic organs radium may be added to advantage. Radiation is indicated in every case, as much suffering is relieved, toxemia lessened, and the patient made more bearable to those about him.

L. S. G.

HUBENY, M. J. *X*-Ray Treatment of Exophthalmic Goiter. (*Illinois Med. J.* June, 1920, p. 383.)

The writer reviews briefly the history of *x*-ray therapy in goiter and sums up the histologic basis for such treatment. He has used two techniques, one is to give each of these areas (including the thymus) two thirds of an erythema dose, using a 9 inch spark-gap and filtration of 4 millimeter aluminum and one millimeter leather with target skin distance of 8 inches. This dose is repeated in three weeks. The second technique consists in using the same filtration, the same spark-gap and a 14 inch skin distance, applying a half-erythema dose over each of six areas: right anterior thymus; left anterior thymus; right anterior thyroid; left anterior thyroid; right and left posterior cervical ganglionic areas. Roentgenization over the cervical ganglionic areas inhibits thyroid secretion. The second technique is preferred when the patient is not highly toxic, quicker results are obtained with the first technique. Early treatment increases the chances of recovery, exophthalmos disappears in 40 per cent of cases. The first dose should be small to guard against an increased toxemia. Caution should be used in treatment of cases after operation, as there is danger of the production of hyperthyroidism.

L. S. G.

FISCHEL, ELLIS. The Use of Radium in Carcinoma of the Face, Jaws and Oral Cavity. (*J. Missouri Med. Assn.* Vol. XVII, No. 7.)

The recognized methods oftreatment are operative removal, destruction by *x*-ray, radium, high frequency or the actual cautery. The *x*-ray can be relied upon to cure nearly all basal cell epitheliomas of the fact. At present it cannot be depended upon to destroy the more malignant types even when located on the surface. The writer has never seen a lesion located within the mouth benefited by the *x*-rays. Radium has some advantages over the *x*-ray, particularly the fact that a known amount may be buried in a mass. Whatever means are employed, the tumor should be destroyed as completely as possible at the first attempt. If cancer of the lip, the results under radium treatment have been so striking that operation is no wreserved for those who have had paste or unsuccessful operative treatment before. Results within the oral cavity have not been so successful, no cures having been noted. If the growth involves the bony jaw, operation is advised, and is followed by radium.

L. S. G.

VILRANDE, G. E. Observations on the Treatment of Neoplasm. (*Brit. Med. J.*, February 14, 1920.)

The writer reports a number of interesting case histories of various malignancies treated by radium. He thinks that there is no doubt as to the value of radiation of the site of glands after removal, and pleads for the routine raying of the scars after lip operations. Rodent ulcers do best under radium. Sarcomata are much more easily inhibited than are carcinomata. Breaking down malignant glands as follow an epithelioma of the lip, does not do well under *x*-ray treatment. Neoplasm of the lungs reacts to hard, heavily filtered rays, but the writer has not seen one disappear. He suggests that perhaps the frequent occurence of epithelioma on lupus that has been treated by small doses of unfiltered rays may have some significance. Larger doses of harder, more heavily filtered rays are indicated in radiotherapy. The writer has doubled and tripled his dosage in the past two years.

LEIGHTON, W. E. Inoperable Cancer. (*J. Missouri Med. Assn.* Vol. XVII, No. 7.)

The responsibility for inoperable cancer rests (1) with the quack cancer specialist, (2) with the patient who neglects to consult a physician, (3) with the physician who fails to recognize the disease, or who attempts superficial surgery. The diagnosis of external cancer is not very difficult. Ulcerations which do not heal readily should arouse our suspicions, and tumors of all descriptions demand early investigation. The laity and the physicians must be educated to the fact that early diagnosis and operation will cure a large percentage of cancer cases. Palliative operation should be undertaken where possible. The re-

moval of ulcerating and offensive masses by cauterization, electro-thermic coagulation or electric dessication may accomplish wonders. Deep roentgen therapy after removal of the skin has given excellent results.

L. S. G.

SEMON, H. C. The *X*-Ray Treatment of Acne Vulgaris. (*Brit. Med. J.*, May 22, 1920.)

The etiology and pathology of acne is that the effect of the rays on acne lesions is the inhibition of the physiologic action of the secretory cells of the sebaceous glands, and the dissolution of the fibrous capsules of the infected comedo. Whether or not this is correct, it remains a fact that the *x*-rays will cause involution, both of the comedo and the deep nodular abcsess and reduce scarring to a minimum. For simple cases unfiltered rays from a tube backing up between 4 and 5 inches spark-gap are used, giving a dose of four fifths Sabauraud B tint. This is not repeated within ten days. An erythema is not desirable.

When pustulation and dermatitis are marked, treatment is preceded by a few days' application of antiseptics and detergent lotions, after which doses of two-fifths B tint are given at ten-day intervals. In the more advanced stages, with intra- and sub-dermic nodules, periglandular fibrosis, etc., harder rays from a tube backing up between 5 and 6 inches of spark-gap are used, with five millimeters of aluminum filter, giving a full pastille dose. After two weeks half-pastille doses may be given at ten-day intervals. Local relapse is rare.

Acne can be permanently cured, no matter in what stage it may be, by judicious *x*-ray treatment.

L. S. G.

BRYAN, LLOYD. The *X*-Ray as an Aid in Diagnosis of Non-Tubercular Pulmonary Conditions. (*California State J. Med.* Vol. XVIII, No. 6.)

Lung abscess is seen as an irregular area of increased density, fading out gradually into normal lung tissue. If the cavity is only partly filled with fluid, a gas bubble may be seen above the fluid level. The large area of consolidation about the cavity may be misleading, and the surgeon will be disappointed in finding so small a cavity. Abscess must be differentiated from bronchiectasis in which condition the indurated areas are usually multiple. The peribronchial thickening of bronchitis never reaches the periphery. Primary and secondary pulmonary malignancy must be differentiated from both lung abscess and tuberculosis. Metastatic sarcoma give a picture identical with that of multiple small abscesses. Tuberculosis may be confused with pneumoconiosis, and may be coincident with it. Diagnosis should not be made from an *x*-ray examination, which is only an aid, and must be correlated closely with the clinical findings.

L. S. G.